IUCN Forest Conservation Programme

Non-timber Forest Products

Ecological and economic aspects of exploitation in Colombia, Ecuador and Bolivia

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Universiteit Utrecht

Development Cooperation Netherlands

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IUCN'S FOREST CONSERVATION PROGRAMME

IUCN's Forest Conservation Programme coordinates and supports the activities of the IUCN Secretariat and members working with forest ecosystems. The goal of forest conservation is achieved through promoting protection, restoration and sustainable use of forest resources, so that forests provide the full potential range of goods and services.

The programme makes contributions to policy at various levels and uses field projects to derive lessons to feed into the policy debate. The principles of Caring *for the Earth,* published jointly by IUCN, WWF and UNEP in 1991, are applied to these projects, which combine the needs of conservation with those of local communities. One major activity is to develop coherent and informed policies on forest conservation in order to advocate the translation of policies into effective actions. IUCN frequently advises major development institutions on forest issues, to ensure that conservation priorities are adequately addressed in their projects and programmes.

The Forest Conservation Programme receives generous financial support from the Government of the Netherlands.

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Prince Bernhard Centre for International Nature Conservation fosters and facilitates strategic and applied research and training on the conservation and sustainable exploitation of natural resources and biodiversity. The Centre is interested in conservation and development projects including an implementation component. It works in bilateral or multilateral cooperation with universities and NGOs in tropical countries. Follow-up to the study presented in this book has led to further research and a training programme on sustainable and multiple exploitation of forest products in Northern Bolivia. This programme, which involves eight Bolivian and five Dutch scientists, is a result of cooperation between the Universidad Tecnica del Beni, the Instituto para Hombre, Agricultura y Ecologia in Riberalta (Northern Bolivia), the Government of the Netherlands and the Prince Bernhard Centre.

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Contents

Introduction

This report is the result of a study of the value and the ecological impact of the exploitation of non-timber forest products in Colombia, Ecuador and Bolivia. It is based on information derived from literature, statistics, interviews and a field survey in Bolivia.

The value of non-timber forest products should not be expressed only in economic terms, since these products are important in many aspects of the lives of people who live in or near the forest. The value of local use and parameters for measuring it are outlined in Chapters 2 and 3.

Non-timber forest products also have importance at national and international levels, as illustrated by the development of medicines based on plant extracts. The potential value of related intellectual property rights is discussed in Chapter 4. Calculation of the Net Present Value, in the same chapter, demonstrates that it is necessary to calculate value over a long period of time in order to make correct estimates. Although several studies suggest that the value of extraction of non-timber forest products is higher than that of other types of land use, it is very difficult to be more specific about these findings.

Chapter 5 contains information about the volume and value of export and production of non-timber forest products in Colombia, Ecuador and Bolivia. Experience from the past illustrates the vagaries of the market cycle as it has applied to specific commercial products, particularly rubber and quinine.

Ecotourism can be seen as another product of tropical forests. The value of ecotourism at local and national levels is discussed in Chapters 4 and 5. Sustainability of exploitation is discussed in ecological, economic and socio-cultural terms in Chapter 6.

Several commercial extraction systems are not sustainable and lead to over-exploitation, as is the case with palm heart (Chapter 7). In addition, the benefits of exploitation are not equally distributed among the people involved in extraction and processing.

It is recommended that the sustainability of extractive systems be improved by:

- developing legal and institutional structures that will give greater ownership of resources to those who harvest them, thus stimulating a vested interest in stewardship;
- determining sustainable harvest levels; and
- incorporating extractive activities into the land-use planning of relevant agencies.

Background

Certain areas are set aside and protected as nature reserves to conserve the biodiversity of tropical rainforests. Harvesting forest products is usually not allowed in these reserves. Only about five per cent of tropical rainforest is now legally protected (Sayer and Wegge, 1992) and it seems unlikely that this area will increase substantially in the next few years.

Within a few decades, if current deforestation rates continue (Myers, 1988a), rainforests will be confined to these protected areas. It is almost certain that this will lead to a significant loss of species, although the patterns of species extinction are still poorly understood (Whitmore and Sayer, 1992). To prevent this loss of species, conservation of biodiversity should also take place outside strictly protected areas; for example, in areas where conservation is combined with some system of harvesting of forest products. This can occur in combination with exploitation of the forest.

For centuries, tropical rainforests have been inhabited by people who use its products for subsistence and trade. These forest-dwelling people have established sophisticated methods of sustainable production. Employing specific practices, they use the forest and its products while maintaining the ecosystem and while simulating the natural dynamics of the forest.

In trying to combine sustainable development and conservation within tropical forests, many governments and international agencies focus on rediscovering these methods of sustainable production. The exploitation of non-timber forest products is an important component of such methods.

Not only do non-timber forest products have a high economic value (de Beer and McDermott, 1989; Falconer, 1990; Myers, 1988b); in certain circumstances they can be harvested without threatening biodiversity (Myers, 1988b). The establishment of the first extractive reserves in Brazil in 1990 was an attempt to bring into practice a new strategy for the conservation of biological diversity as well as for sustainable development (Gradwohl and Greenberg, 1988; Allegretti and Schwartzman, 1987).

The establishment of extractive reserves serves two purposes:

1. **improving the lives of forest-dwelling people.** Creating extractive reserves grants legal protection and extraction rights to the traditional users of forest resources. Establishing extractive reserves may significantly improve the livelihood of people living in the reserve area (Allegretti and Schwartzman, 1987; Fearnside, 1989).
2. **protection of biodiversity.** Exploitation of non-timber forest products may help to preserve a significant part of the biological diversity of the area by allowing only sustainable harvesting of a limited number of non-timber forest products.

The Netherlands Minister for Development Cooperation is interested in developing and applying strategies for sustainable development and for the conservation of biodiversity (DVL/OS, 1991). He therefore commissioned the Netherlands Committee for IUCN and Utrecht University's Special Chair on International Nature Conservation of the Department of Plant Ecology and Evolutionary Biology to:

- review current knowledge and experience on establishing extractive reserves and discuss possibilities for further work in this area;
- collect and review information on the economic value of non-timber forest products and on the sustainability of their exploitation.

Objectives and approach

Initially, the aim of this study was to evaluate whether the system of extractive reserves could meet the objectives of both development and conservation. It also set out to assess socio-economic and ecological conditions related to sustainable extraction of non-timber forest products. The study focuses on the Andean countries, as does the Dutch government's development work in Latin America.

For several reasons the focus of the study had to change slightly:

- in the Andean countries, several non-timber forest products are harvested and exported on a large scale but no legal extractive reserves have yet been established;
- there is no systematic monitoring programme to assess whether development and conservation objectives are achieved.

Monitoring should include an economic component (for development objectives) and an ecological component (for conservation objectives). In order to monitor and evaluate these components it is necessary to devise a way to measure the economic value of non-timber products and the ecological impact of non-timber exploitation.

The present methods for calculating the value of forests and related forest policies are narrowly focused. Economic models tend to focus on the production of timber and rarely include other factors, such as non-timber forest products or regulation of habitat. Peters et al. (1989) suggested that extractive use of non-timber forest products may generate higher income than timber exploitation. They estimated the potential value of non-timber forest products in one hectare of tropical forest, but did not speculate whether this value could be achieved in practice or extended to a larger area.

In traditional systems of resource exploitation, hunting, gathering and agriculture are carried out in an integrated way. Establishing extractive reserves, to allow such sustainable resource use practices to continue, will help to address both resource conservation and local development issues. Commercial exploitation of non-timber forest products is sometimes characterized by high and increasing harvest levels, however. There is also a lack of involvement by traditional forest inhabitants. Over-harvesting may lead to the exhaustion of natural resources (Vasquez and Gentry, 1989). It is not known if this intense harvesting is sustainable or which indicators are suitable for evaluating its impact on the ecosystem.

After consultation with the advisory board of this study, it was decided to redefine the objectives of the study. Revised objectives were as follows:

- Which forest products have a significant economic value, and how can exploitation of these products contribute to the socio-economic development of forest inhabitants?
- How can the ecological sustainability of the extraction of non-timber forest products be measured, and what information is available about the sustainability of extractive systems?

The present study draws on the experience of the Netherlands Committee's report on the economic value of non-timber forest products in Southeast Asia (de Beer and McDermott, 1989) and on the knowledge and expertise of Utrecht University.

This report is based on the following sources of information:

- international publications available in The Netherlands;

- information from government institutions, data banks, libraries, etc., collected in countries during two visits to South America;
- interviews and discussions with experts in the countries involved, in the Netherlands and during several international meetings;
- visits to sites where non-timber forest products are being extracted and processed, and extensive field research in Bolivia.

Details on export and production of non-timber forest products are given in Chapter 4 and are presented in various tables.

Definition

There is more than one definition for non-timber forest products. De Beer and McDermott (1989) define them as "...all biological materials other than timber which are extracted from natural forests for human use." This definition excludes the use of wood for timber, but it includes the small scale non-commercial use of wood for poles, charcoal and fuelwood.

Myers (1988b) explicitly includes the role of genetic resources. He uses the term "non-wood products" which he defines as "...all harvestable items other than timber and fuelwood..." and subdivides them into minor forest products and genetic resources. Falconer (1990) takes into account the scale of forest use and defines non-timber forest products as "...those forest products, including by-products..., that are not processed by large forest industries". This excludes large-scale exploitation, such as occurs with palm heart in Colombia.

In this study, however, the definition of non-timber forest products does not include any system or scale of extraction. The definition used is adapted from de Beer and McDermott (1989): non-timber forest products are "...all biological materials other than timber, fuelwood and carbon which are extracted from natural forests for human use." The explicit use of wood (not only timber) for fuelwood and charcoal is excluded, although this use is certainly important in the local economy. Yet, the origin of fuelwood and charcoal is often difficult to trace; it may come from farmland, shrubland or forest. In 1985, for example, the annual fuelwood consumption in Colombia was estimated at 9.6 to 12.5 million tonnes in addition to another million tonnes that was converted into charcoal (Departemento Nacional de Planeación, 1990).

Non-timber forest products can be categorised in different ways. For ecological purposes one can use the following classifications:

- parts of individual plants, such as leaves, bark and latexes; or

- parts of the population life cycle, such as seeds, flowers, eggs, or entire plants or animals.

Many plant parts can be harvested without destroying the individual plant, while the harvesting of parts of animals (horns, feathers) usually entails killing the animal.

Anthropological and ethnobotanical studies complement these systems with classifications based on types of use: edible, construction material, technology, remedy or commerce (Prance, et al. 1987). For industrial purposes, classification is based on raw materials: rubber, dyes, fibres, cork, tannins, resins, gums, fats and oils (Smits, 1989).

In traditional resource use, agriculture and the extraction of wild species are usually carried out as integrated activities. Similarly, current extraction is nearly always accompanied by agriculture, which is practised on small areas of land scattered throughout the forest. Old growth fallows, which are scarcely distinguishable from the forest that surrounds them, still render fruits and other products, decades after being abandoned as agricultural land.

The introduction and loss of cultivars is a dynamic process in such a system of resource use (Boster, 1984) and plant species are present in all stages of domestication. The dispersion of varieties was enhanced by the indigenous communities' practice of moving regularly, leaving behind and taking with them the results of their agricultural selection.

It is believed that 500 years ago the human population of the Amazon rainforest was larger than it is today (Dufour, 1990; Denevan, 1976). Human management has significantly influenced the frequency of occurrence of certain species in the forest. Consequently, the present forest has been affected by both human activity and natural factors. The high frequency of occurrence of some species appears to be a result of human activity. Balée (1988) has argued that babassu palm (*Orbignya phalerata*) and Brazil nut (*Bertolletia excelsa*) forests, among others, should be considered anthropogenic, because the predominance of these trees is associated with evidence of human settlement. He estimates that at least 11.8 per cent of terra firma in the Brazilian Amazon is covered by forests which have been influenced by human activities.

This study includes only those products that clearly originate in the forest and have not been recently planted. It excludes products which are found in forested areas only as a result of human activity; for example, *Bixa Orellana* (achiote) and many citrus species.

Ecotourism[1] can also be considered a non-timber forest product. It is included in several parts of this report, although it is discussed only briefly, since more comprehensive studies have been published on its status and its impact on the ecology and the economy of tropical rainforests (Boo, 1990; Lindberg, 1991).

Focus of the report

The study focused on tropical rainforest ecosystems for three reasons:

1. The ecosystems have a high priority for conservation in the countries involved (Departemento Nacional de Planeación, 1990) and the Netherlands government is aware of their value (Tweede Kamer, 1990-1991).
2. Their biodiversity suggests that there is potentially a large number of useful non-timber forest products in tropical rainforest ecosystems.
3. Utrecht University has carried out research on the ecological impact of exploitation of tropical forests. This knowledge was expanded during the course of this study.

Colombia, Ecuador and Bolivia were chosen for these reasons:

- The Andean countries are of special interest for the Dutch Development Cooperation (DVL/OS, 1991).
- There is a need for more information about the value of non-timber forest products from the rainforests of these countries (Fearnside, 1989; Prance, 1989; Balick, 1985).
- The situation in these three countries might be representative of other Latin American rainforest countries. The countries are different in terms of size, population and infrastructure, and different products are important in each of them.
- With a focus on Latin America the Netherlands committee for IUCN could extend its knowledge and compare its experiences with a similar study previously carried out in Asia (de Beer and McDermott, 1989). In addition, the knowledge and experience of Utrecht University in Latin America could be used.

In Brazil, many innovative approaches to the extraction of non-timber forest products are generated and tested (see next page). Much has already been published about Brazil, however, and so preference was given to countries with less readily available information. Peru was also of interest but had to be excluded from the study because of its unstable political situation. A systematic survey of available data from other countries has not been carried out; however, some information from outside Colombia, Ecuador and Bolivia has been used in the text as a comparison and some of this data is presented in the appendix.

The exploitation of two important products is described in detail in Chapter 7 in order to evaluate the problems in developing new non-timber forest products. Extraction of Brazil nut in Bolivia and palm heart in Colombia were selected because of their importance in the regional and national economies: there is a foreign market for them and they are being exploited on a large scale. Furthermore, their growth patterns differ as does their exploitation.

Knowledge and experience about these extractive systems can provide a framework to evaluate other products. The information in Chapter 7 is based on existing literature and on experience gained during a field study on the regeneration of the Brazil nut in northeast Bolivia and several excursions in the palm heart-producing area of southwest Colombia.

Extractive reserves in Brazil

Introduction

About 300,000 people in the Brazilian Amazon region are dependent on natural rubber extraction (Schwartzman, 1989). Originally they were organised on rubber estates called *seringais.* The tappers lived in a debt peonage system known as *aviamento.* They had to pay usufruct rights in kind to the estate owners; there was no monetary circulation. Free rubber tappers have emerged in the last 20 years in places where the rubber barons have left or sold the estate to cattle ranchers.

The idea of creating extractive reserves initially emerged in 1985 in the Brazilian state of Acre, where rubber tappers cooperated to counteract deforestation and the expulsion of resident populations (Allegreti, 1990). An important feature of this initiative was that the forest residents suggested the idea themselves and presented it to the Brazilian government and multinational lending institutions (Allegreti and Schwartzman, 1987). The concept has now been accepted by these institutions as a potential strategy for the sustainable development of some of the Amazon's fragile tropical forest lands.

Concept

The extractive reserves strategy focuses on combining traditional activities with new non-extractive uses to promote long-term maintenance and improvement of the traditional forest economy (Almeida, 1990).

Extractive Reserves are defined by the Brazilian government as "...forest areas inhabited by extractive populations granted long-term usufruct rights to forest resources which they collectively manage" (Schwartzman, 1989).

This definition is compatible with that used for IUCN's Protected Areas category VIII, multiple-use management area or managed resource area (WCMC, 1992)[2]. The state assumes ownership of the extractive reserve and cedes it for exclusive use by practitioners of traditional extractive activities for a minimum of 30 years, in accordance with specific regulations governing land use (Schwartzman, 1989). The land cannot be sold or converted to non-forest use. Small clearings for subsistence crops are permitted; usually not exceeding five hectares per family or one to two per cent of a reserve (Fearnside, 1989). Only the perimeter of the entire group of land holdings within a given rubber stand is delineated, and deeds for individual family units are not issued. This arrangement avoids potentially disruptive privatization and preserves the current form of land division, with its subtle borders, that predominates in the rubber stand. Individual families retain the right to tap in their holdings within the reserves.

On rubber holdings, each family occupies 200 hectares or more. In extractive reserves the average area set aside per family is only 50-100 hectares, which is far too small. It also seems unlikely that sufficient land will be set aside for all tappers. Up till the end of 1992 nine extractive reserves had been established in an area of 2,201,000 hectares involving 7,560 families. Ten additional extractive reserves are in the planning stage (pers. comm. Allegretti, 1992). Reserves are administered as associations or cooperatives by a group of people elected by the local inhabitants.

Valuing non-timber forest products

Tropical rainforests fulfil several functions (DVL/OS, 1991):

- production of timber and non-timber products;
- regulation of regional climate, ecological and atmospheric processes and the prevention of erosion;
- habitat for people who depend on them for their livelihood;
- provision of information for science and technology, education and aesthetic experiences.

These different functions make it difficult to assign an economic value to the rainforest in general or to non-timber forest products in particular (McNeely, 1988). It is necessary to calculate this value, however, so as to be able to compare the economic importance of non-timber forest products with the value of products from alternative land uses.

Traditionally, the value of tropical forests has been judged only in financial terms, by focusing on its productivity (McNeely, 1988). This is no longer an appropriate indicator of the total value of tropical forests, for two major reasons (Munasinghe, 1992).

Lack of market pricing

No market prices exist to value the non-marketable goods and services produced by forests. The uncertainties regarding valuation methods make it difficult to include the status of some important functions in financial equations such as the Gross National Product (Gilbert et al., 1990).

It is even more difficult to deal with non-extractive uses like cultural values. These are inherent values and are difficult, if not impossible, to quantify. There are several strategies that can be applied to estimate market prices, such as shadow prices and willingness-to-pay (WTP).

The 'option value' is the value of people's knowledge of the properties and possibilities of non-timber forest products. Option value indicates a potential source of information and is, strictly speaking, not a value of the product itself. It is very difficult to determine because it deals with a future value. Very little experience exists on calculating the option value of non-timber forest products.

Compounding these problems is the fact that the functions of the forest are appreciated differently by different social groups. On the national level the production of the forest is the most important, while on a local level habitat may be most valuable.

Valuing resources

Natural resources are not treated as national capital and are not reflected in national income accounts. Their exhaustion or degradation is not considered to be a loss of capital. The first step toward including the value of natural resources is the establishment of an NRA, or Natural Resource Account (Gilbert et al., 1990). An NRA can present information on the pattern of environmental activity and its effect on natural resource stocks. An NRA consists of a physical account and a value account. The physical account includes information on:

- the growing stock;
- growth and reproduction;
- harvesting; and
- deforestation and degradation or depletion.

NRAs have been carried out for Indonesia (Repetto et al., 1989) and for Costa Rica (Solorzano et al., 1991) among others. Both studies encompass timber resource accounts but include non-timber forest products only to a limited extent.

These factors demonstrate that there is no standardized approach in valuing non-timber forest products. Therefore, before discussing the traditional economic value of non-timber forest products and of ecotourism, several approaches that differ from this classical economic approach will be described.

The following chapters will try and identify, describe and sometimes quantify the values of non-timber products at local and national levels. An assessment of economic value is hampered by a lack of market information and market pricing. Non-timber forest products are not always traded on the market and prices are not available. Methods exist to establish "shadow prices". Shadow pricing is the process of deriving prices for a good or service when there is no monetary market or when the market fails to price goods based on their true value.

Multiple values of tropical forests

Non-timber forest products represent only a part of all goods and services derived from land under forest cover. Non-timber products also contribute to the total potential forest value. Furthermore, tropical forests have a number of values other than non-timber products (DVL/OS, 1991):

- production of timber;
- regulation of regional climate, ecological and atmospheric processes and prevention of erosion;
- habitat for people who depend on them for their livelihood;
- source of information for science and technology, education;
- aesthetic experiences (ecotourism), cultural and religious values; and
- option value.

There are several techniques available to calculate the benefits derived from forest land, including the use of non-timber forest products. Yet it is difficult if not impossible to quantify a total value for forest managed under a certain regime, since:

- costs and benefits of certain goods that are not sold on the market are not readily available;
- costs and benefits of services (regulation of climate, provision of information) are not easily quantifiable; and
- the discount rate is unknown.

Several publications have discussed the problems and limitations in quantifying values and benefits of land use/management types; there is no need to repeat these discussions here at length. The following chapters will further discuss the different types of values of non-timber forest products. Chapter 3 will discuss non-market values and Chapter 4 will look at some other values, including option value, net present value and ecotourism. Chapter 5 will discuss the market value of non-timber forest products.

Non-market values

Local value might best be determined by asking people what they value most from the forest, especially in areas where forest resources are dwindling (Falconer, 1990). Godoy and Lubowski (1992) discuss the methodological problems in quantifying this local value and Falconer (1990) and de Beer and McDermott (1989) present parameters for measuring it (Table 1).

Animals are particularly important as a source of protein. Plants are important for food, construction and medicinal uses, not only for Indians but also for more recent inhabitants. Ethno-botanical studies in Latin America focus on use by Indian peoples. This might be reasonable, since these people have the longest tradition of living in the forest, but it is equally important to obtain information from the expanding group of people who have more recently become forest-dwellers.

Plants

Prance et al. (1987) classified plant uses as follows:

1. Edible products: whole plants and plant parts like fruits, seeds, tubers and consumable latex.
2. Construction material: poles used in post and beam construction and canoes and bridges; leaves used for thatch.
3. Technology: a wide variety of applications, including lashing material, pottery glue temper, dye, soap, pipe stem and arrow points.
4. Miscellaneous: toys, dog-fatteners, fermentation aids and perfume.
5. Remedies: plant material used for the treatment of sinusitis, congestion, diarrhoea, headaches, vomiting, fever, bleeding wounds, snakebite, cradle-cap, cancer sores; as insect repellents, aphrodisiacs, hallucinogens and also for fertility regulation (Berlin, 1984) and dental care (Lewis and Elvin-Lewis, 1984). The World Health Organization

(WHO) identified 20,000 species of medicinal plants all over the world, a great majority of which have their origin in the tropical forests (Levingston and Zamora, 1983). WHO estimated that approximately 80 per cent of the population of developing countries still rely on traditional medicine for their primary health care (Maries et al., 1988).

6. Religion: the significance of plants for religious purposes, in magic and myths. Luna (1984a, 1984b) reports on the use of plants by shamans (Indian medicine men). The plants are believed to teach *vegetalistas* or *maestros* how to diagnose and cure illnesses, how to perform other shamanic tasks and how to use medicinal plants.

Faust (1988) describes the position of plants in the cosmology and mythology of Coconucos Indians in Colombia. Many plant species have mythical properties that determine the way in which they are used. Several plant species are supposed to have spirits. These species play a special role in the healing practices of a shaman, especially in diagnosing health problems with the help of dreams or hallucinations. Mythic properties are related to physical properties of the species. "Warm" plants, used to cure various diseases, often grow in virgin forest and have a strong taste and smell. A shaman can distinguish over 130 species.

Ritual behaviour is also performed by non-Indians. *Babassu,* for example, is used by farmers in northeast Brazil. These farmers are descendants of colonial settlers who intermarried with Indians and African slaves. The plant has many uses: leaves are used for thatching and basketry and fruits are used for oil. The leaves of the babassu are only cut during the waxing of the moon in order to improve the resistance of the leaves to infestation or deterioration (May et al., 1985a). The plant plays a prominent role in the annual babassu dance and party.

Much information is available on traditional knowledge of plants. Documenting this knowledge is one way of appreciating the local significance of plants and animals. In most Latin American countries there are lists of hundreds or even thousands of useful plant species found within the territory. See Pittier (1978a and 1978b) for Costa Rica and Venezuela; Perez-Abelaez (1956) and Acero Duarte (1979) for Colombia; Bennet (1990) for Ecuador and Cardenas Martin (1969) for Bolivia.

Many of these lists are based on traditional knowledge collected during anthropological, ethnobotanical or ethno-pharmacological studies, describing the role of plants in the local culture (Alcorn, 1984). Table 2 demonstrates the extensive indigenous knowledge of plant and animal species and their uses. This demonstrates the diversity of products being used by indigenous communities and others. There are striking differences among the number of plant species used in different cases. It is difficult to compare the individual studies, however: areas are different in size, habitats of the communities are different and collecting methods vary.

Lists do not supply information on the value of the products, individually or collectively; or the relative diversity of the species. One indication of the value of forest resources is the presence of traditional regulations governing the use of these resources (Falconer, 1990; Table 1). Falconer (1990) gives examples from Africa of user rights regarding trees. Similar systems are illustrated by hunting rules and taboos of Amerindian tribes (Reichel-Dolmatoff, 1978). The shaman can regulate hunting activities by certain commands; these regulations are embedded in the mythology of the tribe. Non-Indian forest dwellers also have taboos and regulations for the use of the forest resources (May et al., 1985b).

Values of tree species

In order to obtain quantitative information about the use value of the forest, Prance et al. (1987) studied four indigenous Amazonian groups: the Ka'apor and Tembe in Brazil, the Panare in Venezuela and the Chácobo in Bolivia to determine the number of tree species utilised as a percentage of the total number of tree species (Table 3). In each case it was possible to indicate a "use value" for each species and each plant family by assessing the cultural importance of each species as "minor" or "major". Pinedo-Vasquez et al. (1990) did a similar study on a 7.5 hectare plot in a *ribereno* community. The residents live on the river banks in Peru and are of mixed ethnic origin. All communities used more than 50 per cent of the total number of tree species. Most of the species are used for food and construction material.

Commercial exploitation was more important for the *ribereno* community than for Indian communities. This was probably due to a better market infrastructure and to cultural differences. Originally the categories "firewood" and "edible game animals" were also included in the inventories. However, the categories appeared to be too broadly defined as almost all species could be used for those purposes (Prance et al., 1987). Detailed knowledge existed about different species and Boom (1987) noted that in emergency situations any tree species would be used as fuelwood. However, the Chácobo Indians normally focused on only 22 species for use as fuel for smoking rubber and for cooking, ten species of which appeared to produce the dense smoke that is necessary to cure and coagulate the rubber before it is transported.

Of the nine species with a high use value for the Ka'apor, five seem to grow exclusively in terra firma forest (primary non-flooded forest). They are not encountered in old swiddens, swidden fallow or the swamp forest. Five of the ten species used by the Tembe grow this way.

Some use categories have been underestimated in this study, because only trees with a diameter at breast height (DBH) greater than 10 centimetres were sampled. Many medicinal plants, for example, are not tree species. In addition, not only vascular plants are being used. Fungi (so called "Indian bread") are eaten by various groups of Indians in the Amazon region and by caboclos and settlers, but at a far lower rate than could be expected from its abundant distribution. From reports of Zaire and Nigeria it seems that the use of fungi as food and in traditional medicine is more important on the African continent (Prance, 1984) than in the Amazon region. The Yanomami Indians are the exception to the rule in this region: 21 species of fungi are collected and provide an important dietary supplement. The species that are used most often *(Polyporaceae)* grow primarily on dead wood in abandoned fields.

Pinedo-Vasquez et al. (1990) compared the non-timber forest products observed in their forest inventory with the supply of non-timber forest products at the nearby market in Iquitos. Forest fruits represented over half of the non-timber forest products on the market. Construction materials were the second largest category, followed by a limited number of craft and remedy species. In addition, ten exudate-producing species have nearby markets. However, many of the products are not sold from the community where the inventory took place.

The two studies reveal that different indigenous groups use different plant species for the same purposes. This reflects the wide range of material available, since not all species grow within the range of all tribes. The Indians were able to find suitable plants for their needs, regardless of the local species composition of the forest (Prance, 1989).

Palms

In the study by Prance et al. (1987), palms appeared to be the most useful of all families. Other families that are important for at least two of the four indigenous groups include *Lecythidaceae, Chrysobalanaceae* and *Malpighiaceae.*

Palms are the most versatile group of plants; they provide all of the basic necessities like food, shelter, fuel and fibre, as well as many ameliorants, such as spices, oils, waxes, gums, poisons and medicines (Plotkin and Balick, 1984). Palms are important for daily household needs (Boom, 1986) and also for religious purposes (Beckerman, 1977; Barfold and Barslev, 1988; Wilbert, 1976; Schultes, 1974; Reichel-Dolmatoff, 1989).

Palm fruits are the most important fruits collected from the wild for the Yanomami Indians in Venezuela and Brazil (Anderson, 1978). They provide protein that supplements erratic supplies of meat and are also used for wine-making (May et al., 1985a). Palm wood and fibres are widely used by forest dwellers for bow wood, matting material and construction (Schultes, 1977). Plotkin and Balick (1984) list 48 palm species that have known medicinal uses among aboriginal people in South America. For the Indians from the Colombian Vaupes region palm trees provide a model for their social structure. Palm pollination, as observed and interpreted by the Indians, is comparable with human reproductive behaviour and from this analogy a series of social norms, ritual practices and mental processes is derived (Reichel-Dolmatoff, 1989).

Palms are used so widely and for such a variety of products because their physical construction differs from that of other plants. Within palm stems there is a series of small strands, comprising phloem, xylem and fibres, which makes them very strong (Balick, 1984). It is not only their physical structure that is important, however.

Palms are relatively abundant in neotropical ecosystems because they have adapted to a great variety of habitats. For example, they have developed gaseous exchange of their roots in wet areas. According to Braun (cited by Beckerman, 1977) it is probably the abundance of palms (*Geonoma sp.* in this case), rather than their other properties, that accounts for their popularity as roofing material. Enormous amounts of leaves are needed for roofing. Beckerman (1977) estimates that 750,000 leaves of *Geonoma* are used for one roof of a community house of the Barí Indians in Venezuela and Colombia. *Lepidocaryum tessmannii,* an understorey palm of terra firma forest, is also used for thatching. It can attain densities of about 2,500 to 3,500 axis per hectare. It was calculated that two hectares are needed for one roof (Kahn and Mejia, 1987). Although palms are vitally important to the economy, information about their taxonomy is very limited (Balick, 1984).

Animals

Dourojeanni (1985) reviewed the use of wild fauna in the Amazon countries. The importance of wild meat has decreased for Amazon urban populations, where it has become a luxury or contraband article.

In the Amazon area, more than 85 per cent of meat consumed is provided by hunting and fishing, despite the availability of cows, pigs and farmyard birds (Table 4; Dourojeanni, 1985). The price of meat from domestic animals, especially cows, is very high; these animals are raised exclusively for sale to urban centres. Peru has consolidated statistics about the meat production from wild animals. Dourojeanni (1985) estimated a production of 13,100 metric tonnes in 1976.

A large number of animals are hunted for subsistence. Redford and Robinson (1991) calculated the number of birds and mammals killed annually by the rural population of Amazonas state, Brazil. This 1,564,445 square kilometre area supports a rural population of 573,885 (in 1982). Every year, they hunt approximately 3.5 million vertebrates for local consumption, including 2,824,662 mammals and 530,884 birds. Castro (1977) extrapolated data from 1973 on consumption of monkeys from the Loreto Department in the Peruvian Amazon region. He estimated that the 249,000 inhabitants consumed 370,000 monkeys; a rate of 1.5 monkeys per inhabitant annually.

In general, less protein is provided by wild fauna for the inhabitants at higher altitudes of the Amazon basin than for those living at lower or middle altitudes. The diversity and density of fauna is lower on the Andean slopes and exploitation pressure is higher (Dourojeanni, 1985). In lowland areas which have been occupied for a longer period, the population densities of the fauna have decreased, due to hunting, change in habitat and other human activities.

In Coto Chato, Brazil (Table 5; Smith, 1976), the contribution of wild fauna to the protein requirement is less than in Nova Frontera or Leonardo Da Vinci. The Coco Chato area has been occupied by Transamazon settlers for 15 years longer than the other communities. In parts of Amazonian Peru, wildlife provided all animal protein consumed by colonists. In Nicaragua wildlife also seems to meet the demand for meat and fish consumed by the Miskito Indians (Robinson and Redford, 1991). The green turtle (Chelonia *mydas)* was the most important game.

The majority of the Amerindians in Amazonia rely on fish, rather than game, for their principal source of animal protein (Dufour, 1990).

Tukano Indians in Colombia get 45 per cent of their protein from fish, 12 per cent from meat and 4 per cent from insects (Dufour, 1990). Ferguson Laguna (1990) calculated that in Venezuela the Indians receive enough daily protein from hunting, while the non-Indian peasants do not (Table 5). Smith (1976), who studied settlers along the Transamazon highway, concluded that these people do not receive enough protein (Table 6). In Ecuador, hunting and fishing provide about 25 per cent of the total caloric intake of the Siona-Secoya Indians living in and around the Cuyabeno Reserve (Nations and Coello Hinojosa, 1989). The Tukano Indians in Colombia get only nine per cent of their calories from meat and fish, however (Dufour, 1990).

Big game like deer (*Mazama spp.*), peccary (*Tayassu spp.*) and tapir (*Tapirus terrestris*) constitute 50 per cent or more of the meat comsumed from terrestrial wild animals (Table 7). The tortoise species (*Geochelone denticulata*) was previously important as human food in Andean countries, as was the water turtle (*Podiocnemis spp.*) in the Amazon and Orinoco regions (Hildebrand et al., 1988). Both species have declined in importance due to excessive game hunting and egg collecting (Dourojeanni, 1985). For example, riverine Indians in Peru harvest the eggs of various species that nest on river beaches. Sea turtle eggs and other eggs are also important sources of food in many parts of Central America (Robinson and Redford, 1991), but reptiles provide the most important source of eggs. Eggs of lizards, the iguana (*Iguana iguana*) and the tegu (*Tupinambis sp.*) are frequently consumed by rural people in Latin America. In some areas such eggs have added value as they are thought to be aphrodisiacs. Iguanas are also hunted for their meat (Cohn, 1989). In some areas fish is a more important source of protein than terrestrial animals (Table 4, see also Rodriguez and van der Hammen, 1991). Land invertebrates may represent a significant percentage of animal protein consumption (from three to seven per cent) by natives as well as by settlers (Dourojeanni, 1985). However, Smith (1976) states that Transamazon settlers have never been observed to consume arthropods. Insects are an excellent food source as they can have a protein content in excess of 75 per cent (Myers, 1982). Among the species most often consumed and considered as delicacies are the larvae of certain palm tree beetles (*Rynchophorus spp., Rhinostomus spp.*) and the queen ants of the *Atta* and *Acromyrmex genera.* Dragonflies, various mollusca and frogs are also eaten (Prance, 1984; Figueroa, 1983).

Smith (1976) and Fergusson Laguna (1990) draw attention to cultural differences in hunting practices. Indian groups hunt more wildlife than settlers of non-Indian descent. They generally exploit a much wider range of animals and tend to focus more on small animals, such as monkeys and birds (Table 7). The forest-dwelling people of Surinam, for example, hunt at least 27 mammal species, 24 bird species, three turtle species and two lizard species. Colombia's Maraca Indians hunt at least 51 species of birds, including ten species of humming-birds (Robinson and Redford, 1991).

Preferences may derive from the mythology of the tribe (Reichel-Dolmatoff, 1978). People who have more recently come to the forest concentrate on relatively large animals such as peccary, tapir and deer and also on reptiles. Crocodiles are hunted by both groups. Rats and mice, notorious agricultural pests, are a source of food for some Indian groups but they are not eaten by new colonists (Smith, 1976). Rabbit meat is shunned by Amazonian peasants and people from the northeast of Brazil, since they find it too slippery (Smith, 1976). The meat of tapirs is considered inferior; that of capybara (*Hydrochoerushydrochoerus*)is avoided by the colonists but is eaten in cities in Venezuela during Holy Week (Dourojeanni, 1985).

Data from Fergusson Laguna (1990) support these observations on food preferences, except for the information on reptiles. During food shortages, inhabitants hunt for species that they would not normally eat. Fergusson Laguna (1990) observed that indigenous and *Campesino* communities hunt primarily for food but also for market purposes. Small species are more abundant than large species and are more often sold at markets. The favourite and more expensive meats are usually those from the species of primates, agoutis (*Dasyprocta spp.*), pacas (*Cuniculus spp.*) and birds (Dourojeanni, 1985) but peccary and deer also fetch high prices.

Animals are not only used for food. Skins, feathers, teeth, nails, wax, horns, shells, etc. are used in medicines, clothing, ornaments, handicrafts and tools (Campos-Rozo, 1987; Redford and Robinson, 1991). For a long time, the exploitation of feathers has been an important part of wildlife utilization in parts of the neotropics. The feathers of birds such as the quetzal (*Pharomacchrus mocinno*), the roseate spoonbill (*Ajaia ajaia*) and the macaw (*Ara spp.*) were highly valued because of their decorative qualities. Feathers are still important in the ceremonies of Indian groups in Latin America (Robinson and Redford, 1991).

Medicinal uses of wildlife continue in many parts of Latin America, as can be seen in the markets of La Paz, Bolivia and Belém, Brazil, where dried animal parts are sold for use in rites (Robinson and Redford, 1991). Pets seem to be popular among all people. It was found that in four Kayapó Indian villages, 31 species of animals were kept as pets. In the Brazilian city of Rio Brazil, 15 species of primates were kept as pets. Caged song birds and parrots are also common throughout Latin America (Robinson and Redford, 1991).

Hunting varies greatly during the year. This is due to the changing availability of game and the number of hunting trips (Smith, 1976; Campos-Rozo, 1987). The consumption of wild meat varies, especially among settlers who do not know how to preserve meat (Dourojeanni, 1985).

The Desana Indians and their neighbours in Colombia attribute undesirable qualities to certain game animals; consequently the consumption of these animals is restricted. The restricted game is mainly tapir, deer and white-lipped peccary (Reichel-Dolmatoff, 1978).

Dynamics

Although it is not always possible to describe the use value in monetary terms, non-timber products are economically important for many people. Estimates of the number of people in the Brazilian Amazon who make their living from extractive activities vary from 500,000 (Seul, 1988) to 1,500,000 (Schwartzman, 1989). In the whole Amazon region roughly 2,500,000 people live in tropical rainforests and depend on them for a large part of their livelihood. They use non-timber forest products for the following reasons:

- the forest is nearby, the products are easy to obtain and free of charge (de Beer and McDermott, 1989; Dourojeanni, 1985);
- forest products serve as emergency food that supplements food supplies reduced due to agricultural disasters (Hazlett, 1986);
- people are accustomed to certain tastes and habits (de Beer and McDermott, 1989).

The patterns of use are not static; Indians, for example, have become more sedentary. This may change the pattern of use of non-timber forest products. Increasingly, Indians are consuming tinned meat, which has higher prestige but requires cash for purchase and draws the hunter into a market economy (Robinson and Redford, 1991).

Table 1. Indicators of value

Value of non-timber forest products to rural households.

qualitative indicators

1. response of people to resource degradation;
2. value of forest resources as reflected in tenure and usuary rights and their evolution;
3. uses of non-timber forest products and knowledge about them;
    - seasonal variation in the use and importance of non-timber forest products;
    - the emergency or buffer role of non-timber forest products;
    - number of non-timber forest product species known and used;
4. attitudes, preferences and perceptions of rural people to change regarding non-timber forest products;
5. use and distribution of indigenous forest species in homegardens, farms and fallow;
6. questioning the people or groups (women, rural poor) who rely on non-timber forest products.

quantitative indicators

7. quantity and frequency of forest product collection and consumption;
8. numbers and percentage of community who collect, consume, trade, process and/or manufacture non-timber forest products;
9. percentage of nutrition (calories, proteins, etc.) provided by non-timber forest products;
10. percentage of household time spent on activities related to non-timber forest products;
11. availability of raw material from the forest/non-timber forest products.

indicators related to monetary value

12. gross income and the contribution of income from activities related to non-timber forest products to the household budget;
13. payment for labour for activities related to non-timber forest products versus alternative employment;
14. prices received by collectors;
15. availability and market prices for marketed non-timber forest products and substitutes.

Based on: Falconer (1990) and de Beer and McDermott (1989).

Table 2. Plant species

Number of plant species, cultivated and from the wild

group	country	number of species	source
Jicaque	Honduras	49 in use, 43 additional names, no uses defined	Lenzt, 1986
Huastec	Mexico	679 total, of which 550 medicinal	Alcorn, 1984
Cabecar and Guaymi	Costa Rica and Panama	more than 85	Hazlett, 1986
Coconucos	Colombia	more than 130	Faust, 1988
Siona-Secoya	Ecuador	224	Vickers and Plowman, 1984
Siona-Secoya	Ecuador	46 liana species[1], of which 31 for food and medicine	Paz y Miño et al., 1991
Quechua	Ecuador	212 mostly medicinal[2]	Alarcon, 1988
Quijos-Quechua	Ecuador	120 medicinal plants	Maries et al, 1988
Quechua	Peru	250	Franquemont et al., 1990
Shipino-Conibo	Peru	211 medicinal plants[3]	Tournon et al., 1986
Jívaro	Peru	720 wild species, of which 120 fruits	Berlin, 1984
Cháboco	Bolivia	305 total: 102 food plants of which 75 wild; 22 fuelwood, 68 construction and craft	Boom, 1987
Belem market	Brazil	150 species, wild and cultivated	van den Berg, 1984
country-wide	Peru	56 natural dye plants	Antúnez de Mayolo, 1988
country-wide	Guyana	75 liana species	Potters, 1989

Notes: 1. out of 98 liana species in a one-hectare plot; 2. inventory of large area (length several hundred kms); 3. inventory of a 700-km stretch of river

Table 3. Number of tree species

Tree species (DBH>10 cm) encountered in five plots, percentage of useful tree species and (for Ribereños) percentage of useful individual trees per use category.

	per cent of total number of species					per cent of total number of individuals
	Ka'apor, Brazil; 1 ha	Tembé, Brazil; 1 ha	Chácobo, Bolivia; 1 ha	Panare, Venezuela; 1 ha	Ribereños, Peru; 7.5 ha	Ribereños, Peru; 7.5 ha
total: useful species	76.8	61.3	78.7	48.6	60.1	66.4
edible	34.3	21.8	40.4	34.3	17.0	22.2
construction	20.2	30.3	17.0	2.9	18.8	18.9
technology[1]	19.2	21.0	18.1	4.3	2.8	4.2
medicine	21.2	10.9	35.1	7.1	6.0	3.0
commerce	2.0	5.0	1.1	4.3	13.3	13.7
other[2]	9.1	4.2	1.1	0.0	5.0	2.6
total species	**99.0**	**119.0**	**94.0**	**70.0**	**218.0**	**3,780.0**

Source: Prance et al. (1987), except for riberenos: Pinedo-Vasquez et al. (1990).
Notes: 1. Pinedo-Vasquez et al. (1990) substitute a more restrictive category "crafts" for "technology". Crafts include: uses for wooden bowls, canoe paddles, handbags and others. Lashing material is included in "construction"; 2. Category "other" includes religion.

Table 4. Meat consumption

Fresh meat consumption in the Amazon region of Peru (average: g/day/person).

	from Pucallpa to Nauta (Ucayali River)	in Jenaro Herrera (Ucayali River)
fish	135.6	158.3
game	52.0	75.8
farmyard birds	22.1	25.7
pigs	12.0	10.2
cows	insignificant	insignificant
total	**221.7**	**270.0**

Source: Dourojeanni (1985).

Table 5. Game meat consumption

Fresh meat from wild animals (excluding fish) in different sites of the Amazon region.

site	average meat consumption **g/day/person**	**years of observation**
Brazil		
Nova Fronteira[1]	25.9	1973-1974
Leonardo da Vinci[1]	42.1	1973-1974
Coco Chato[1]	6.6	1973-1974
F. N. Tapajoz[2]	246.0	1978
Peru		
Pachitea River[2]	460.0	1965
Ucayali River[2]		1966
J. Herrera[2]	75.8	1971-1972
R. Pichis[2]	649	1980
Venezuela		
Indians[3]	110.0	n/a
mestizos[3]	25.0	n/a

Sources: 1. Smith (1976); 2. Dourojeanni (1985); 3. Fergusson Laguna (1990)

Table 6. Protein needs

Percentage of protein needs provided by wild fauna in communities on the Transamazon highway.

site	**per cent of protein demand**
Nova Fronteira	17
Leonardo da Vinci	20
Coco Chato	2

Source: Smith (1976).

Table 7. Game meat consumption: species groups

Percentage, in weight, of different animal groups in different case studies.

	Brazil[1]			Venezuela[2]	
per cent weight	**Nova Fronteira**	**Leonardo da Vinci**	**Coco Chato**	**Indians**	**Campesinos**
large mammals	92.2	87.8	27.4	50.5	79.4
monkeys	0.2	0.0	1.3:	11.7	3.3
other small mammals[5]	4.8	7.6	65.6	19.8	10.5
total mammals	**97.2**	**95.4**	**94.4**	**82.0**	**93.2**
reptiles	1.9	4.1	3.0	5.4	4.4
birds	0.8	0.5	2.6	9.0	2.2
other	_	—	—	3.6	0.2

	Peru[3]			Colombia[4]	
	Pachitea River	**Ucayali River**	**Indians and Mestizos**	**Ticuna Indians % weight**	**% kills**
large mammals	49.3	51.9	—	88.2	34.9
monkeys	6.6	9.3	—	1.7	10.8
other small mammals'	24.3	25.7	—	5.0	16.9
total mammals	**80.2**	**86.9**	**91.0-92.0**	**94.9**	**62.6**
reptiles	17.2	9.9	4.0-6.0	3.8	9.7
birds	2.6	3.2	3.0-4.0	1.3	27.7
other	—	—	—	—	—

Sources and other notes: 1. Smith (1976); 2. Fergusson Laguna (1990), quoting other sources; 3. Dourojeanni (1985), quoting other sources; ethnic background unknown; 4. Campos-Rozo (1987); 5. Small mammals include agoutis, squirrels, sloths, armadillos, among others

Other values

Option value

The term "option value" is often used in discussions about finding and developing new medicines. It refers to the possibility of a product having value in the future. Farnsworth (1988) and Myers (1988b) argue that plants represent a source that is still untapped of compounds for new medicines. Of all prescriptions dispensed in the USA during the last 25 years, 25 per cent contained plant-derived active compounds. In addition, 74 per cent of the chemical compounds used in drugs in industrialized countries have the same or similar uses in traditional medicines (Farnsworth, 1988).

Traditional medicinal use of a certain plant species may be the first indication that it contains a useful chemical compound (Bird, 1991). There is a need to research ethnopharmacological information in the search for new medicines (Elisabetsky and Salvio-Nunes, 1990; Plotkin and Balick, 1984). The knowledge of how to use plant species is disappearing faster than the species themselves (Plotkin, 1988; Hazlett, 1986; Lewis and Elvin-Lewis, 1984). This is one reason traditional use of medicinal plants has received special attention within ethno-botany (for example: Ayala Flores, 1984; Ayensu, 1983; Davis and Yost, 1983; Eisner, 1991; Grenard et al., 1987; Heyde, 1985; Mello, 1980 and the extensive series *De plantis toxicariis e mundo novo tropicale commentationes,* published by Schultes, 1985).

It is believed that medicines and products developed on the basis of indigenous knowledge generate billions of dollars of revenue. Up to now, forest-dwelling people have not been compensated for their knowledge by the companies that used this knowledge to develop and market new products. Developing mechanisms to compensate the actual owner of these intellectual property rights is still only at an early stage. Such mechanisms are now being discussed in the framework of the global biodiversity convention.

Bird (1991) describes the method used by Biotics, a company that acts as a broker for developing countries and finds buyers for their medicinal plants among pharmaceutical companies in industrialised countries. The suppliers and Biotics receive an initial payment for the plants. The company determines if the material has economic value; if this leads to marketable products, the suppliers are guaranteed royalties in return for the material. In another case, in 1991, the USA-based pharmaceutical company Merck paid US$1 million to the Costa Rica government for the rights to exploit and develop active components from a group of forest plants.

Net Present Value

The value of a natural resource at any specific point in time is the Net Present Value (NPV) of that resource, i.e. the present (discounted) value of expected future earnings. The NPV only takes into account quantifiable economic value. In formula:

$$V_0 = \frac{P_1Q_1 - C_1}{(1+i)} + \frac{P_2Q_2 - C_2}{(1+i)^2} + \frac{P_nQ_n - C_n}{(1+i)^n}$$

V_0 value at t=0
P price
Q quantity
C costs
i discount rate
n time

The NPV does not calculate the value of the product that is actually being harvested but instead calculates the value of the production capacity. The constraints in calculating the NPV of renewable biological resources are:

1. There are numerous uncertainties about the resilience of natural resources after exploitation and thus of the life expectancy of the resource (Godoy and Lubowski, 1992). This implies that Q and therefore C are not constant.

2. In one accounting period, the price of a natural resource can experience two different changes (Gilbert et al., 1990): the natural resource can be depleted, which means physical depreciation; or the unit value of the stock may rise or fall, which means a capital gain or loss.

The overall value depreciation is the sum of the physical depreciation minus capital gain or plus capital loss. The NPV does not take into account any loss or gain of other non-economic values, such as biodiversity, knowledge, etc.

3. In comparing present and future receipts and costs of natural resource use, future earnings and costs are downgraded by some discount rates. Economists disagree as to which discount rate to use (Repetto et al., 1989). A high discount rate means that long-term investments become more expensive

than short-term investments. The result is that some renewable resources may be exhausted and long-term sustainable development based upon these resources is no longer an option. Conversely, at a lower discount rate, higher value is attached to future land use. People will make longer term investments if they feel that sustained yield of a resource has a higher value.

Several attempts have been made to calculate the value of tropical forests based on the production of non-timber forest products. Heinzman and Reining (1988) calculated the NPV of forests in the Northern Peten of Guatemala based on the extraction of xaté (palm leaves used for ornamental purposes). They compared this system with the NPV of milpa agriculture (a traditional mixed crop system, predominantly corn and beans). In reference to the constraints mentioned above, they assumed that:

- the time horizon was infinite;
- real prices (i.e. those that have been adjusted for inflation) would stay constant;
- management regimes would not change in the future.

In Guatemala the discount rate at the time of publication was nine per cent. The NPV was calculated at three different percentages to demonstrate the effect of different discount rates. Two scenarios were presented; one with no plant mortality and one with five per cent mortality each year. Their calculations led them to conclude that the benefits derived from the harvesting of xaté from the forest are greater than those of milpa agriculture (Table 8).

Alegretti and Schwartzman (1987) compared the incomes generated by cattle ranching, agriculture and extraction of rubber in the Brazilian state of Acre. While the area occupied for extraction decreased from 1970 to 1980, and the area for cattle ranching and for agriculture increased dramatically; the per hectare value of extraction increased much more than either meat production or agriculture (Table 9). At the same time rubber increased its share of overall exports from the state. Hecht and Cockburn (1989) add that forest extraction of rubber and Brazil nuts has the highest NPV of present land use in Acre.

Nations and Coello Hinojosa (1989) did a similar study with river turtles. Raising river turtles can produce 22,000 kg per hectare per year of turtle meat in small ponds in the Cuyabeno Reserve in Ecuador, with a value of US$ 20,000. In contrast, beef cattle production in the same region produces only 50 kg of meat per hectare per year, with a value of US$ 47. Data from the same authors gathered in the Brazilian Amazon indicates that five large animal species (peccary, tapir, paca, deer and agouti) can be harvested without decreasing natural populations at the average rate of 0.24 kg of meat per hectare per year, with a value of almost US$ 5 per hectare per year. If other species are included that are normally consumed, the total value of wild meat reaches more than US$ 40 per hectare per year. In addition, each hectare of swamp and river can produce US$ 145 worth of caiman skins per year. In total, Cuayabeno Reserve could produce millions of dollars per year.

Peters et al. (1989) estimated the NPV of non-timber forest products in one hectare of tropical rainforest near Iquitos, Peru. They compared the NPV with timber logging and livestock ranching. Based on their estimates of the density, biological productivity and market price of each fruit tree and palm, and using a five per cent inflation-free discount rate, they concluded that the fruit and rubber production of one hectare of forest has a greater NPV than timber (Table 10).

The NPV of sustainable fruit and latex harvests, assuming that 25 per cent of the fruit crop is left in the forest for regeneration, is estimated at US$ 6330 per hectare. However, there can be a great difference between this theoretical value, which is based on an inventory of the products in the forest, and the actual value of what is in fact being sold on the market. Padoch and de Jong (1989) measured the potential and the actual annual value of non-timber forest products in Iquitos, and found that the actual value of the goods extracted only reached 2.5 to 3 per cent of the potential value, based on the quantity of products in the forest.

Godoy and Lubowski (1992) reviewed studies that estimate the economic value of non-timber forest products (Table 11). They concluded that the values of non-timber products calculated in these studies were incompatible. There were variations that might be explained by the biological and economic diversity of the different study sites sampled. Also, different kinds of non-timber forest products have different yields. For example, extractivism is more likely to be economically successful in forests where a few marketable species dominate (Browder, 1992).

In addition, the full array of non-timber forest products is not always taken into account in these studies. Although hunting is reputed to produce benefits comparable to those realized in converting forest to farmland, few authors have estimated the economic value of the fauna extracted. Neither has the combined economic value of plants and animals been measured (Godoy and Lubowski, 1992).

Furthermore, even when studying the same goods, independent valuations conducted at nearly the same time and place produced different results. A single plot can yield different values depending on the valuation technique used. It remains unclear to what extend the outcome of these calculations can be extrapolated to larger areas and whether it can be concluded that extraction of non-timber forest products is in general more profitable than other types of land use.

Table 8. Agriculture vs. non-timber products

NPV (US$/hectare) for milpa agriculture and xaté extraction.

discount rate	milpa		xaté	
	constant yield	declining fertility[1]	constant yield	declining production[1]
5 per cent	288	172	480	240
9 per cent	182	138	380	171
15 per cent	130	114	160	120

Source: Heinzman and Reining (1988)
Note: 1. decline of 5 per cent per year.

Table 9. Annual production value: Acre, Brazil

(US$/hectare) for different types of land use in Acre, Brazil.

	beef	agriculture	extraction
1970	3.24	14.25	2.49
1980	3.72	19.42	8.99

Calculated on basis of total extractive value for the state of Acre/total area dedicated to specific type of land use. Source: Alegretti and Schwartzman (1987)

Table 10. Income and NPV

Value (in US$) from one hectare of forest in Peru.

	annual income	NPV
fruit	400	6,330 (fruit and rubber together)
rubber	22	
clear-cutting	1,000	0
selective cutting	310	490

Source: Peters et al. (1989).

Table 11. Economic values of non-timber products

Survey of Net Economic Values of non-timber forest products

location	value (US$/ha/year)	comments
Venezuela	0.75	experimental caiman harvest
Mudumalal Sanctuary, India	3.0	0.02 elephants/hectare at US$ 1,500/elephant excludes costs of domestication and training price refers to a domesticated animal 10 per cent discount rate assumed
Ituri Forest, Zaire	3.18-0.50	at US$ 1/kg, estimate excludes costs.
Amazon, Brazil	4.8	estimate is gross return/hectare/year, only values flora
Sarawak, East Malaysia	8.00	wildlife over 1 km^2
Iquitos, Peru	16-22	based partly on community diaries, only values flora
Amazonian region, Brazil	40	potential value of sustainable annual bushmeat harvest
Hantana, Sri Lanka	50	50 randomly chosen households surveyed in 3 villages; used contingent valuation and opportunity cost approach; estimate excludes cost of extraction, only values flora
Kalimantan, Indonesia	53	NPV of cultivated rattan at US$ 529/hectare over 25 years with real discount rate of 10 per cent
State of Para, Brazil	110	value after selective thinning of competitors and pruning of acai palm
Veracruz, Mexico	116	only values flora; estimate excludes lumber and coffee
Amazon, Ecuador	120	values wildlife over 500 km^2
Jenaro, Herrera	167	values only harvest of wild camu camu
Iquitos, Peru	420	values the inventory in 1 hectare; only values flora.

Source: Godoy and Lubowski, 1992

National economies

Sources of information

Information on the production and export of non-timber forest products has been obtained from:

1. National export registers. Information is maintained by government institutes in charge of foreign trade. These institutes are beginning to use internationally standardised codes for products; in the future this will make it easier to compare data from different countries.

2. Forest production registers, maintained by forestry or agricultural departments.

3. Data on international trade in endangered species, mostly animals, which is compiled by the World Conservation Monitoring Centre (WCMC) from annual reports submitted to the Convention on International Trade in Endangered Species (CITES) secretariat by member states.

4. Secondary sources, special reports, case studies, local market studies, etc.

In Colombia, information on exports and imports have been published for the Tropical Forestry Action Plan by Delgado (1990). Total and annual averages of both quantity and monetary value are available for 1970 to 1989 (Table 12). This information is based on extracts from Customs files. Additional information has been collected by Rincon (pers. comm. and Ramirez Perdomo (1988). Where data is contradictory, preference is given to Delgado (1990), which is more recent and complete.

INDERENA, the Colombian government's Natural Resources Institute, keeps track of information on exploitation of products from the National Forest Estate. Few non-timber products are being registered (Table 13). Data from areas that belong to the jurisdiction of a Regional Development Corporation is only collected on a regional basis and is therefore not included in Table 13. Over 25 per cent of Colombia's forest is being managed by corporations, particularly in departments like Putumayo, Nariño and Caqueta (Jimenez, pers. comm.).

In Ecuador national export data is registered by the Central Bank (Table 14). Export permits are granted on the basis of national quotas; in the case of forest products, these quotas are set by the Forest Department. Data on national production is not available, although the Ministry of Agriculture receives regular reports from its 21 provinces on the production of timber and "other products".

In Bolivia information is sparse and difficult to obtain. The publications of the National Institute for Statistics are the most important sources of information. The Food and Agricultural Organization (FAO) carried out a study on the opportunities for exploitation of non-timber products within the framework of the Bolivian Tropical Forestry Action Plan, (Mendoza, 1991). This study included data on exports, based on customs information collected by the Bolivian Institute of Export (INPEX) (Tables 15 and 16).

For a number of reasons, these sources give only a rough indication of the real amount and value of the trade in non-timber forest products.

Not all non-timber forest products marketed are registered. Delgado (1990) lists some products that are marketed in Colombia; unfortunately, no information is available about their quantity or value (Table 31). In Colombia, Ecuador and Bolivia relatively few non-timber forest products are being registered, although Brazil has a more extensive list (Tables 26 and 27).

In addition, calculating the actual volume and value of the production and export is not straightforward. Production figures are sometimes based on issued permits, instead of the amount that is actually being harvested, which is quite often greater. Only the official export is registered; the illegal export, which is not registered, can be equal to the official amount (Mendoza, 1991). Harvesting and trade in some products; for example many animal species, is illegal. It is difficult to obtain data about this illegal trade. Registration of seized goods might allow countries to estimate the volume of illegal trade. Clerical errors also lead to inaccurate statistics; mistypings and miscalculations have been reported (Instituto de Estadisticas, 1989).

The origin of products in the export registers is not always clear (i.e. geographical, species, plantations versus semi-natural ecosystems). Also, the use of common names is confusing. One name may be used for different products, or one product may have different regional names. Furthermore, it is difficult to compare historical data with recent information because the borders of nations have changed.

The lack of distinction between products from natural stands and those from plantations presents a problem for this study, which focuses on products from natural forests. Unless otherwise specified, only products that clearly originate in tropical forest are considered here.

These circumstances may lead to . misleading or inconsistent information (see Table 15, note 5). Comparing different sources may reveal different data for the same product (see Table 12 or compare Table 26 with Table 27). It would require a special study of each product from harvest to market to obtain insight into real production figures and monetary values. Such research was beyond the scope of this study.

Consequently, the figures presented in this report should be regarded as approximate estimates. In spite of these limitations, the figures that are presented in this chapter are the most reliable ones available. Although the figures in the official registers may differ from actual numbers, registered information can at least make trends visible.

Plant products

Latex-producing plants

Products made from latex are divided into two categories: elastic and non-elastic gums. The term elastic gums is often replaced by the Spanish terms *caucho* or *jebe*, because these are the most common mixtures of elastic gums. Strictly speaking, caucho stands for *Castilla spp.* (*caucho bianco*), *Sapium spp.* (*caucho bianco*) or Ficus *spp. Jebe* or *seringa* means *Hevea spp.* (Dominguez and Gomez, 1990). Castilla *spp.* were the most important elastic gums from Central America, the Pacific coast and Colombia's Andean foothills.

The natural distribution of *Hevea spp.* is restricted to the *varzea* (riverside) of the Amazon and Orinoco regions. In Colombia, *Hevea brasiliensis* can be found only in the southernmost part of the country. The gum of *H. brasiliensis* is the purest and most manageable of all gums. Other *Hevea spp.* produce gum which is less valuable.

Commercial extraction and export of gums started in the 19th century. Important industrial applications had been discovered which made use of gum's specific properties: the material can isolate electricity, and is impermeable and elastic. The invention of the vulcanization process by Goodyear in 1840 was a landmark in the demand for rubber (Seul, 1988).

Toward the end of the 19th century, exploitation produced short but intense economic upheavals in different regions throughout the country. In Colombia exploitation started with *caucho bianco* (*Castilla spp*). This produced a premium latex that was sometimes mixed with lower quality latex from other species. *Caucho* could be found in more accessible places than *jebe.* The exploitation of *caucho* was destructive: trees were cut down and the latex was collected from carves afterwards. Only after the source of *caucho* was exhausted did people turn *to jebe.* The method of obtaining the latex of *jebe* was different. The bark of the tree was weakened along the whole length of the trunk by beating it with a pole, cuts were made in the bark in an unsystematic way and *lianas* were tied around the trunk in order to extract all the latex.

In Colombia there were striking differences between the exploitation strategy of jebe and that of *caucho:*

1. The latex of jebe is found in inter-connected conduits, so one cut in the bark is enough to release it. In *caucho* the latex is stored in isolated cells and has to be released with many cuts.

2. *Jebe* trees can be cut every three days during a period of three to five months, whereas *caucho* trees can be cut only once or twice a year.

3. *Caucho* trees seem to be more susceptible to diseases after deep cuts are made and the trees often die after they are treated. Because of these factors it was possible to develop a sedentary system for exploitation of *jebe,* but not for *caucho.*

Latex exploitation changed as demand increased and as transport improved with the arrival of river steamers. This stimulated the takeover of the *seringales* by new investors, who were interested in continuous exploitation. As extraction became sedentary there was a need to exploit the resource without exhausting it and new systems for carving the trees were introduced (Seul, 1988).

There was a difference between the situation in Brazil and Colombia. In Putumayo, Colombia, only species of lower quality occurred. Since there was enough cheap labour production was not modernized. The *jebe* of Brazil was of higher quality and productivity than the *caucho* of Colombia. Because there was a shortage of labour in Brazil, there was a compelling need to modernize production. This provided Brazil with a virtual monopoly on the world market.

The world consumption of *caucho* increased rapidly: from 1,965 tonnes in 1850 to 50,668 tonnes in 1900, and to 374,745 tonnes in 1919. In 1906 rubber production on plantations in Asia started up. It proved to be much more economical. In 1911 production from plantations in Asia amounted to 15,520 tonnes, increasing to 70,117 tonnes in 1914. For the first time, plantations produced more rubber than wild sources, a situation which has continued to the present time.

In South America production on plantations was hampered by South American Leaf Blight (Richards, 1992). The proportion of Amazonian rubber on the world market fell from 60 per cent in 1900 to two per cent in 1930. During World War II the last revival of Brazilian rubber production occurred: it tripled between 1941 and 1945 (Seul, 1988). The world rubber market is still increasing but there is more demand for synthetic rubber, which makes up about 70 per cent of the market. For some purposes natural rubber will continue to be used because of its unique properties.

In 1984 rubber production in Colombia was estimated at 982 tonnes, 469 tonnes of which was wild rubber from the departments of Amazonas, Putumayo, Vaupes and Guaviare (Ministerio de Agricultura 1990). Most wild rubber is bartered with neighbouring countries. Colombia imports and exports rubber and rubber products; exact flows are difficult to trace. It is estimated that production is about five per cent of national consumption (Delgado, 1990). The value of annual wild natural rubber production is estimated at about US$ 6.2 million (based on data from Instituto de Estadisticas, 1989).

In Bolivia income from rubber exports has decreased since the mid 1980s; until then, Bolivia had its own rubber processing factory. This explains the difference between the production and export of rubber, since part of the production was processed for the national market (Tables 15 and 16). Smuggling of rubber to Brazil may also explain part of the difference. The tenfold increase in the production of rubber balls (*bolache*) between 1986 and 1987 remains unexplained (Table 16) as this is not reflected in a corresponding increase in exports.

Balata and bullet tree (*guta-percha*) are non-elastic gums. *Balata* is produced from *Mimusops balata* but the name is also used for latex from *Manilkara amazonica* and other species. The name *balata* is often confused with *gutapercha*, although, strictly speaking, the latter refers to latex from the bullet tree (*Palaquium spp.*). Both types of latex are used for industrial purposes. Since the latex from batata-producing trees can be harvested only once in 15 to 20 years, a sedentary exploitation system did not develop. Exploitation was destructive: trees were cut down or died because too much latex was tapped or the cuts were too damaging.

Chicle is the collective term for another group of non-elastic gums. Chicle is used for the production of chewing gum. The *Sapodilla* or *Nispero* tree (*Manilkara zapota*) is the principal source and is found in the natural forest in Mexico and Guatemala. It is cultivated mainly for its fruits in the rest of equatorial America. Other species are *Manilkara achras* and M. *chick* (real chicle), which are exported from Belize. The extraction method for chicle is the same as it is for *balata;* that is, by felling the tree. Overexploitation has led to its near extinction in Yucatan, Mexico. Many other species have been used to replace it. In Colombia, a large quantity of chicle was exported at the beginning of the 1980s. The latex of the *Pendare* tree (*Couma macrocarpa*) is used as an alternative or additive for chicle. *Pendare* latex is also used for medicinal purposes. This latex is also called *sorva* latex or *leche caspi.*

In Brazil, *sorva* latex is harvested from *Couma rigida* and *C. utilis. Sorva* was also traditionally extracted by felling the tree. Techniques have recently been devised to tap the trees instead (Prance, 1989). Extraction took place in Colombia until 1973 and it is still important in Brazil.

Medicinal *plants*

Quinine is a pharmaceutical product produced from the bark of the *cinchona* tree and is used mainly as a basis for medicine to treat malaria. Malaria is now mostly a tropical disease, although until the end of last century it also affected large regions of the United States and Europe (Dominguez and Gomez, 1990).

The genus *Cinchona* has an intricate classification. *Cinchona condaminae, C. officinalis* and *C. pubescens* are some of the species that produce quinine; related species belong to the genera *Ladenbergia* and *Remijia.* These species produce alkaloids which differ from quinine but which also have economic value.

Quinine was isolated for the first time in 1820. The history of its exploitation is very similar to that of rubber exploitation. The demand for quinine rose in the 19th century with the increase in European activities in the colonies (Dominguez and Gomez, 1990). Commercial exploitation started in the Ecuadorian Andes near Loja and spread to Alto Peru (Bolivia), Peru, Quito and Nueva Granada in Colombia.

In Colombia, quinine extraction started at the end of the 18th century (Patiño, 1980). In the next century it was accompanied by a continuous colonisation of new areas. Fierce competition in exploitation and marketing led to over-harvesting, similar to the history of *Concho* extraction. Individual labourers always had to choose between felling the tree or only stripping its bark. The lack of a system to regulate harvesting meant there was always the danger of others harvesting the bark that was left behind. There was also a susceptibility to disease after the bark was stripped, although this could be decreased by tapping moss onto the trunk (Domiguez and Gomez, 1990). The annual export volume rose to over 5,597 tonnes in 1880, when Colombia became the principal export country in the world (Patiño, 1980).

The last boom of naturally-harvested quinine occurred during the American civil war. In the second half of the 19th century Great Britain and Holland established plantations of *Cinchona spp.* in Asia using genetic material from South America. The Dutch applied modern selection and propagation methods in Indonesia and were able to produce a variety with a high quinine content. This, together with the efficient production system in Indonesia, broke the monopoly of naturally-harvested quinine.

From 1880 over-production existed on the world market. Natural stands in Latin America could no longer compete with the Dutch plantations, and after 1883 Colombian exports declined steeply. There was a brief revival during World War II, but since then the demand has continued to decrease. Attempts to grow *cinchona* in plantations in Colombia were not successful.

In Bolivia quinine production was controlled and marketed nationally until 1970 to supply medicines to people in high-risk malarial areas. The country possessed a state-owned quinine factory and harvesting was a state monopoly. Between 1970 and 1990 a few attempts to grow quinine trees on plantations failed due to lack of a long-term commitment and investment (Mendoza, 1991). From 1970 to 1980 some export occurred; during the 1980s export totals fluctuated but remained low.

Dominguez and Gomez (1990) conclude that the long history of quinine extraction in South America did not result in any modern plantations or prolonged economic benefit for the Andean equatorial region. The world market for quinine is steadily increasing, but Bolivia cannot benefit from the increased demand due to a lack of raw material (Mendoza, 1991). This lack of raw material is caused by over-exploitation and lack of new sources.

The roots of *ipecacuanha* or *raicilla* (*Cephaelis ipecacuanha* and other *C. spp.*) are used for medicinal purposes. Harvesting from the wild occurs and the species is also cultivated. Well-known production areas are Colombia, Nicaragua and Rondônia and Mato Grosso in Brazil. The area of Manaus in Brazil is the centre of production. Annual production in Brazil was around 130 tonnes from 1962 to 1968.

Tonka beans or *sarrapia* (*Dipteryx odorata* or *Coumarouma odorata* and *C. rosea*) are used for medicinal purposes, perfume, resins in soap and as an aromatic for tobacco. *Sarrapia real* (or *yape; Dipteryx punctata*) is used to scent tobacco. No plantations are known in Colombia and harvesting by Indians takes place only from wild sources (Delgado, 1990). Export was very profitable in the last century but *sarrapia* has now been replaced almost entirely by artificial products. Export information exists for Venezuela only, but part of the export probably originates in Colombia. In the first 25 years of this century the annual export of *Sarrapia real* from Venezuela was 170,000 kilograms. Extraction was highly destructive; the vegetation around the trees had to be burned to facilitate harvesting.

Tolu balsam (*Myroxylon balsamum var. genuinum*) and Peru balsam (M. *balsamum var. pereirae*) are used to make ointments and tinctures. Other species of interest are *canime* or Maracaibo balsam (*Copaifera canime*) and *algarrobo* (*Hymenaea courbaril*) (Delgado, 1990). The figures in Table 8 refer mainly to Tolu balsam. Annual world production (1981) of Tolu balsam was about 65 tonnes, of which El Salvador exports 48 tonnes or 74 per cent (Levingston and Zamora, 1983). The resin can only be obtained by cutting and burning the tree, so harvesting is destructive.

Trade in *zarzaparilla (Smilax sp.)* has existed since the first European settlement, at least in Latin America. The root of *zarzaparilla* is in great demand for its medicinal properties, among which is the ability to cure syphilis. In 1853 the export of 11,662 kilograms of *zarzaparilla* was registered from Iquitos. *Zarzaparilla* is harvested from the wild and frequently grown in home gardens, but it has never developed into a major plantation crop. It is discussed here briefly because it is often mentioned as an example of a promising new forest product. Strictly speaking it is not a non-timber forest product because it is not harvested exclusively from the wild. It is therefore not included in the statistics of this report.

Palm products

Palms produce several products that are commercially important. Oil produced from seeds is the most important, followed by fibre, palm heart and others. Some species are suitable as multi-purpose cash crops (Johnson, 1987). Moriche (*miriti* or *aguaje, Mauritia flexuosa*), for example, is a species found in inundated areas; like the peach palm (*chontaduro* or *pejibaye, Bactris gasipaes*) its fruits, leaves, palm heart and stem are used. Palms are mostly used locally by Indians and colonists of the Amazon region and the Llanos, although palm products are also sold in markets in larger cities.

The peach palm has a wide distribution in northern South America and in Central America and is an example of a species that can be found in all stages of domestication. It is presumed that this species was domesticated more than 4,000 years ago (Seul, 1988) and that it is found in Central America because of human activity.

Jessenia spp. and *Oenocarpus spp.* are used for the commercial production of oil and medicines (Balick, 1986). Commercial products obtained from *Murumuru* or *tucum,* (*Astrocaryum spp.*) are palm heart, edible oil and fibres. Fruits of these species are steamed and served in restaurants as appetizers in the major cities of the Amazon. The wild stands are threatened due to destructive palm heart production and habitat alteration (Balick, 1984).

Chiquichique or *piassaba* (*Leopoldinia piassaba*) is used for making ropes and brooms. Its fronds are used for roofing and its fruits for making juice (Putz, 1979). Its distribution is limited to the upper Rio Negro region (Prance, 1989). The Colombian *chiquichique* has often been sold under its Venezuelan or Brazilian name, *piassaba.* Although this practice has been discontinued, it might confuse the figures presented in Tables 13, 26 and 27 (Patiño, 1980).

The palm tree remains alive after harvesting *chiquichique;* cutting the fibres does not damage the terminal bud. Trees are only cut down when demand is high and they are too tall for the usual collecting operations. A mature tree has an annual production of approximately one kilogram of fibre, which is sold for about US$ 0.10. One person can harvest 25 to 30 trees a day. Cutting is usually repeated after two or three years.

In Ecuador palm fibres are used to make Panama hats. The most important species are *toquilla* (*Carludovica palmata*), *mocora* (*Carludovica sp.*) and *totora* (*Scirpus californicus*). Fibres are harvested in the lowlands, but processing takes place in the mountain chains of Ecuador (Budowski, pers. comm.). In the second half of the 19th century Panama hats were also an important export from the Department of Loreto (Peru) to Brazil, comprising between 20,000 and 190,000 hats per year (Coomes, 1991).

The waxy layer on the leaves of *Copernicia prunifera,* known as carnauba wax, is the basis of a multimillion dollar industry in Brazil (Balick, 1984). The wax of this palm is extremely hard, durable and of high quality.

Edible palm fruits are plentiful in Brazil (Johnson, 1982), but only assai (*Euterpe oleracea*) is considered in Brazilian statistics (Richards, 1992). Palm fruits are used in the manufacture of soft drinks and ice cream and production is increasing rapidly. In 1966 there was no record of the extraction of these palm fruits but by 1987 they had become the most important extractive product in Brazil.

In 1979, Brazil earned more than US$ 100 million from the harvest and sale of products from six native palm genera: *Astrocarium, Attalea, Copernicia, Euterpe, Mauritia* and *Orbignya.* The production of palm heart is discussed in more detail in Chapter 7.

Fruits

Tagua

Tagua nuts (or vegetable ivory, *marfil vegetal, la yarina* or *cabeza de negro*) are mainly harvested from *Palandraaequatorialis*and*Phytelephas seemannii*, but also from other *Phytelephas spp.* Tagua is not limited to primary forest; it is also found in different types of secondary forests. In processed form, the nuts resemble ivory and are used in the manufacture of buttons and other ornamental articles. Production and export became important towards the end of last century (Patiño, 1980).

An annual export from South America valued at US$ 5 million was reported for the beginning of the 20th century (Barfod, 1989). Ecuador has always been the main exporter, with Río Bamba as the centre of the processing industry. In 1887 the port of Esmeraldas (Ecuador) received 76.2 per cent of its earnings from the export of vegetable ivory; in 1931 about half its export earnings still came from the same source. By that year, 92 per cent of the tagua nuts imported by the United States came from Ecuador (Barfod, 1989).

Colombia, Brazil, Peru and Panama also produced vegetable ivory. Between 1845 and 1898 Colombia exported 117,876 tonnes of tagua nuts; in 1910 it exported about 16,700 tonnes (peeled and unpeeled) (Patiño, 1980). In the 1920s, 20 per cent of all buttons produced in the United States were made of vegetable ivory. Export decreased sharply during and after the Second World War due to fraud (similar, lower quality species) and substitutes like plastic and Bakelite (Patiño, 1980). In the mid 1980s there was a renewed interest in vegetable ivory and the sale of souvenirs made from tagua nuts is increasing.

Brazil nut

The extraction of Brazil nut is discussed in detail in Chapter 7.

Dyes

In the past the exploitation of several dyes was economically important. *Brasilete* or dyewood (*Ematoxylon brasiletto* or *H. campechamum*) has been exploited for centuries. From 1834 to 1865 the annual export from Colombia of *palo de mora* (*Chhrophora tinctoria*) was between 2,200,000 and 4,800,000 kilograms (Patiño, 1980). After

1873, *pah de mora* disappeared from the statistics. The export of other natural dyes also decreased in the last quarter of the 19th century due to the use of synthetic pigments. Dyewood is still being exported from Belize, however (Table 33).

Tannins

The exploitation of tannins was also much more important in the past. The fruits of *dividivi* (*Caesalpinia spinosa*) and the bark of the red mangrove (*Rhizophora mangle*) from Colombia and Ecuador and of the *pashaco* tree (*Parkia verrutina*) from Peru (Coomes, 1991) were important sources of tannins. Tannins can be extracted from many species that occur in the wild; for example, encenillo (*Weinmannia spp.*), guamo (*Inga spp.*), alcaparros (Cassia *spp.*), palosanto (*Aegiphila spp.*) and mangle (*Rhizophora spp.*).

Dividivi appears in the statistics from 1857 on. Annual export from 1866 to 1871 was between 1,000 and 2,500 kilograms. At present the only registered export is from Brazil. This export includes mangrove (*Rhizophora mangle*) and *barbatimao* (*Strychnodendronbarbadetiman*). *Dividivi de tierra caliente* (*Caesalpinia coriaria*) was an important raw material for Colombia's local tanning industry but overexploitation and lack of proper management have exhausted supplies (Patiño, 1980).

Ornamental plants

No quantitative information is available on the extraction of ornamental plants from the wild. Orchids are very popular both within the tropical countries and abroad, although the extraction of *Anthurium* species, such as *capotillo de barbacoash*, is a recent development. In Central America there is a thriving export in palm leaves (*Chamaedorea spp.*) for ornamental use in the USA and Europe. Processing is very wasteful; 45 to 65 per cent of the leaves are thrown away before export (Heinzman and Reining, 1988).

Other plant products

The Ecuadorian Ministry of Agriculture reports on products such as bamboo (*caña guadua, Bambusa guadua*) and *pambil* (*Socratea exorrhiza* and/or *Iriartea deltoidea*) which are used for construction (Valencio, pers. comm.). Dragon's blood (*Croton spp.*), a well-known medicinal product, is also widely used and is economically important locally. At the moment, however, it is not exported.

Mushrooms are harvested in the pine forests near Río Bamba in Ecuador. As well as being exported, they are an important source of income locally.

Animals

Introduction

Between World War II and the 1970s there was an extensive international trade in wild animals and their products, but since 1970 trade has been restricted by national and international legislation. Brazil restricted animal trade in 1968 and Peru prohibited trade and export in monkeys in 1973. Colombia followed (Whitney, 1977). Prohibition of trade in one country led to an increase in other countries. The export of birds from Bolivia increased enormously during the 1970s, partly because of stricter Brazilian legislation. Many of the Bolivian birds were probably of Brazilian origin (Nilsson, 1981). See Table 19 for other examples.

All countries in Latin America are now members of CITES. CITES member states agree to prohibit commercial international trade in endangered species and to monitor trade in species that may be depleted by trade. Table 20 is based on data compiled by WCMC from reports supplied by CITES members; figures refer primarily to legal trade, but include illegal trade when known (World Resources Institute, 1990).

The totals presented in Table 20 generally over-estimate the actual number of traded specimens because the same specimen could be imported and then exported by a number of countries within a single year. On the other hand, the number of individuals of a particular species involved in trade can also be greater than the numbers reported because of mortality (during capture, transit and quarantine), illegal trade, trade to or from countries that are not CITES members, and lack of domestic trade data (World Resources Institute, 1990).

Permits may be issued for the capture of animals for specific purposes. In Ecuador, around 100 permits are issued annually for the export of flora and fauna, mainly for insect and bird skins (Figueroa, pers. comm.). In Colombia in 1988, about 150,000 animals were legally captured for captive breeding programmes. This figure included 78,000 crocodiles, 1,200 boa constrictors and 100 poison-arrow frogs (INDERENA 1990). In many Latin American countries CITES legislation is widely ignored; it is estimated that one third of the international trade in wild flora and fauna is illegal (Jaeger, 1992). In some cases, the percentage may be even worse. For example, only three per cent of the export of *paraba jacinta* (*Anodorhynchus hyacinthinus*) from Bolivia to the USA is reported to be legal (CDC: Bolivia et al., 1988).

The annual value of international trade in wild flora and fauna amounts to between US$ 5 and 7 billion (Jaeger, 1992). Tens of thousands of primates, millions of birds and tropical fish, about 10 million reptile skins, 15 million furs and one million orchids are traded annually (Jaeger, 1992).

Where available, information on domestic and international trade is presented together in this chapter. It is not always clear whether animals actually come from rainforest areas. Caimans and capybaras, for example, can be found not only in forest ecosystems but also in savannas. Often, bird species are not specified, which makes it difficult to determine their origin.

Food

Although game is no longer present in its former numbers, it is still readily available at many local markets. Unlike the situation in Europe and the USA, game is usually cheaper than the meat of domestic animals, except in areas where wild animals have been largely hunted out (Robinson and Redford, 1991).

Manatee, caiman and river turtles were important sources of commercial meat in the Amazon. There are reports of loggerhead turtle (Caretta *caretta*) being commercialized by Indians from the bay of Urabá, Colombia from around 1760. During the 17th century Europeans established a commercial trade in the meat of the manatee (*Trichechus manatus* and *T. inunguis*). The market increased until 1959, when a minimum of 6,500 animals were traded. Now the sale of manatee is prohibited, although it is still available in local markets.

Several species of caiman, especially *Caiman crocodilus,* are important sources of meat in some areas of the Amazon basin. The current annual trade in meat is estimated at 21,500 to 32,000 individuals.

Traditionally, turtles have also been hunted. Tartaruga *(Podocnemis expansa)* and several other species of freshwater turtles that were once commercially exploited have become endangered. These river turtles are considered a delicacy and can still be found in markets. Other species, such as the green turtle, were also commercially important.

Capybara meat is an important source of protein in several areas in Latin America. A limited local market in fresh and salted capybara meat exists within the Amazon basin. The only large commercial exploitation of capybara meat is in Venezuela. Over 90,000 animals were harvested there for trade in 1981.

Bird eggs and reptile eggs are important food sources in some areas. Of the reptiles, turtles are the most important source of eggs. Freshwater turtle eggs have been exploited intensively in the past for industrial and nutritional purposes.

In the Amazon basin, there were so many tartarunga eggs available that a complete processing industry developed. Oil from the eggs was used for cooking and for lighting. In 1719, the upper Amazon produced 87,300 kilograms of oil from about 24 million eggs. In 1860 this amount doubled due to the industrial demand. In Honduras exploitation still provides an important source of income and is so intense that virtually all nests of the olive ridley turtle (*Lepidochelys olivacea*) have been harvested. Oil has also been obtained from nestlings of oilbirds (*Steatornis caripensis*) (Patiño, 1980).

Furs and skins

The export of skins and furs became important in the 19th century. Most leather is used for luxury goods such as purses, gloves, shoes and overcoats. While deer and manatee were formerly exploited, today the principal sources of leather are peccaries, capybara and, above all, reptiles, including caiman lizards, tegu lizards, crocodiles and, to a lesser extent, sea turtles, toads and snakes (Table 21).

Sea turtle leather originates mostly from the olive ridley and the green turtle and is second in price only to crocodile leather. Crocodiles, especially *Caiman crocodilus*, greatly outnumber all other species in trade. Between 1950 and 1970, five to ten million crocodile skins were traded world-wide annually. It is estimated that one million caiman skins still leave South America each year, despite current legislation in many countries prohibiting such export.

There is still trade in peccary hide, although it is less extensive. A German importer reported a yearly purchase of 36,000 peccary hides from Paraguay (Robinson and Redford, 1991).

Europeans introduced large-scale commercialization of skins in Latin America as they did with leather. Both types of products are sold at luxury markets in Europe, Japan and North America.

The skin trade in the Amazon basin has always focused on a few species: giant otter (*Pteronuro brasiliensis*), river otter (*Lutra longicaudis*), jaguar (*Panthera onca*) and ocelot (*Felis pardalis*, and much smaller numbers of *F. wiedii* and *F. tigrina*). The trade in cat skins started with jaguars at the end of the last century. In the 1960s the cat trade shifted to smaller species, apparently in response to overexploitation of the jaguar and the subsequent decrease in supply. The period between World War II and the early 1970s saw a great increase in the trade of skins that originated in the Amazon Basin (Table 21). The value of the 2,281,400 skins and living animals exported from Colombia in 1973 (Table 21) totalled US$ 15,329,600.

After the 1970s, the international trade in skins decreased dramatically. This was partly due to legislation and probably also due to a lower demand in Europe and the United States because of public awareness. This has not, however, stopped animals being killed for their skins. In 1982, 34,915 skins, 77 per cent of which belonged to carnivores, were seized in Brazil, and in 1986 over 6,000 carnivore skins were seized in Uruguay. In 1983 more than 600,000 hides of *yacare amazonico* were seized in Colombia and in 1988 2,000 macaws from Colombia were intercepted in one action at the Charles de Gaulle airport in Paris (Uribe, pers. comm.). The macaws had a market value of US$ 5,000 each. Illegally hunted skins, such as those of snakes and other reptiles, otters, monkeys, peccaries, etc. (Fergusson Laguna, 1990) are still being marketed.

The exploitation of living wild animals and skins and furs is very wasteful; it has been estimated that for each animal that is exported alive (Patiño, 1980), another five die during capture and transport. Present practices under-utilize the animals that are killed for their skins: the meat is not collected, although a national market exists for the meat of some species, such as the capybara in Bolivia (CDC-Bolivia et al., 1988). This market, although limited, can be extended. Wetteberg et al. (1976) revealed that restaurants in Manaus show considerable interest in serving wild game meat provided it is available regularly. The most preferred species seemed to be tartaruga, paca *(Cuniculus paca),* deer *(Mazama, Odocoileus* and *Pudu spp.),* tapir and peccary *(Tayassu tajacu* and T. *pecari).* This might provide an argument for the establishment of game farms, although expertise in raising animals is still not widespread. Farming could help to relieve pressure on wild species.

In 1988 Colombia started an active policy of stimulating the raising of non-traditional animals for export in game farms or *zoocriaderos.* Export earning from these *zoocriaderos* up to the end of 1990 was US$ 3,346 (INDERENA 1990). The capture of a certain number of specimens from the wild is permitted to obtain a suitable stock of parent material. The actual number of captured animals is unknown, however. The animals are state property and five per cent of the animals raised in the *zoocriaderos* have to be released into the wild. This policy has resulted in 25,196 animals of different species being released up till 1990. Venezuela has a similar programme for the use of capybara and caiman (Fergusson Laguna, 1990).

Feathers

Birds and bird feathers have been exported since the time of Columbus

(Patiño, 1980). Feathers were once very important elements in fashion. In the second half of the last century and the first years of this century, heron feathers were one of the most important export products of some countries, especially Colombia and Venezuela (Patiño, 1980). Between 1899 and 1920 South America — principally Argentina, Brazil and Venezuela — exported 15,000 kilograms of egret and heron feathers, representing plumes from an estimated 12 to 15 million smaller species of birds and 3 to 4.5 million larger ones. To a large extent the trade in feathers has disappeared.

Pets and animals for biomedical research

A few decades ago there was an active trade in officially registered wild animals from the neotropical forests. Leticia, Colombia and Iquitos, Peru were important centres. Each year about 130 animal species (living animals) were exported from Iquitos. The majority of trade was restricted to a relatively small number of species (Whitney, 1977). Monkeys for biomedical research (Moro, 1977) and parrots *(Psittacidae)* for pets made up 50 per cent of the total.

In 1972, the USA imported 27,288 monkeys from Colombia and 16,124 from Peru (Whitney, 1977), with smaller numbers from Nicaragua and Paraguay. There were 339,080 monkeys registered between 1964 and 1974 as exports from Iquitos, yielding US$ 1,460,000. Squirrel monkeys (*Saimiri spp.*), night monkeys (*Aotus spp.*), marmosets of the genus *Saguinus* and capuchine monkeys (*Cebus spp.*) were the most common. In Table 17, Castro (1977) estimates that for every monkey exported, two monkeys died before export. Moro (1977) estimates pre-export loss at 30 per cent. In addition, a considerable number die during transport. For every exported monkey that is registered, one is exported without being registered. Including those animals killed for local consumption (Chapter 3), the total number of monkeys taken from around Iquitos (Department Loreto, Peru) between 1964 and 1974 amounted to 5,056,320 (Table 17). From 1979 to 1984 Bolivia was the most important exporter and re-exporter of wildlife in the neotropics (CDC-Bolivia et al., 1988). The most commonly traded animals were reptiles, monkeys, peccaries and parrots, including six species of parrots from neighbouring countries.

There is a well-established tradition of keeping pets among Indians and people of European descent. Primates and birds, especially parrots and songbirds, are the most popular. Based on information from Dr. S. Figueroa, in Ecuador's Department of

Natural Resources, it was estimated that 10,000 living birds arrive in the country's major cities annually, as well as 1,000 monkeys and 3,300 turtles and tortoises.

There is a thriving export trade in wild animals for pets, particularly parrots (Table 17). Between 1981 and 1986 the USA imported 703,000 parrots from the neotropics. The retail market in parrots in the United States, both wild and captive-bred, is estimated at US$ 300 million. The cardenalito (*Carduelis cucullata*), also highly valued, is cross-bred with canaries to obtain very showy birds. Illegal commercial hunting for this bird is one cause of the species being on the verge of extinction; only 600 to 800 individuals survive in the wild. Ornamental fish and, to a lesser extent, poison-arrow frogs and other animals, have become important exports during the last 20 to 25 years (Patiño, 1980).

Less important than export for pets and for biomedical purposes is the export of animals for zoos. Although small in scale, the zoo trade frequently focuses on rare species (Robinson and Redford, 1991) and on animals like tapir and spectacled bear, which are large and not otherwise traded.

Ecotourism and sport hunting

Globally, ecotourism is one of the fastest growing segments of the tourist industry (Ceballos-Lascurain, 1992). Ziffer (1989) estimates an annual increase of 20 per cent, due to an overall rise in tourism, a growth in specialty travel and an increasing awareness of and concern about the environment.

Estimates of the total value of ecotourism activities vary considerably. According to Lindberg (1991) the ecotourism industry generated between US$ 2 and 12 billion in income for developing countries worldwide in 1988. Ziffer (1989), however, estimated that US$ 12 billion, excluding airfare, was spent annually just by the four to six million US citizens who travelled abroad for nature holidays. Ceballos-Lascurain (1992) estimated that, worldwide, 235 million people — 78 million of whom were bird watchers — went abroad in 1990 for eco-tourism purposes. He estimated that they spent an average US$ 1,000 per person; in total, well over US$ 200 billion.

These amounts, however, relate not just to tropical forests but to all natural or semi-natural ecosystems. Furthermore, it should be taken into account that not all revenue stays in the countries; there is considerable "leakage" of income from tourist activities in less developed economies. This is due to the need to import luxury goods and because many facilities like hotels and lodges are owned by foreigners (de Groot, 1992). The World Bank has reported that 55 per cent of gross tourism revenue in developing countries leaks back to developed countries (Lindberg, 1991).

The ecotourism situation is different in each of the three countries: Colombia, Ecuador and Brazil. In Colombia, INDERENA registered 124,228 visitors to national parks in 1990 (Files INDERENA). Tayrona Park is the most popular site and attracted 81,208 visitors during 1987, about eight per cent of whom were foreigners (Nariño and Silva Ayala, 1988).

In Ecuador, tourism, together with oil, coffee, fish and bananas, has been the most important foreign exchange earner since the mid 1980s. It generates between US$ 133 million and 260 million annually (Feprotur, 1990; Boo, 1990). About 370,000 people, or 12 per cent of the economically active population, are employed in the tourism business. Most visitors come to see parks and protected areas (Boo, 1990). The annual number of visitors to protected areas in Ecuador increased to about 250,000 at the beginning of the 1980s. The actual number of visitors might be considerably higher than the statistics indicate, because the data are not always complete (Files Information Ministry of Agriculture).

Ecuador's most popular site is the Galapagos Archipelago. Each year 60,000 to 125,000 people registered and unregistered visitors spend an average of four to five days on and around the islands. Direct revenue is as high as US$ 700,000 a year. The park's revenue helps to maintain Ecuador's 14 other national parks and reserves, which together bring in only US$ 40,000 a year (Lindberg, 1991).

In Bolivia information on ecotourism is scarce; the industry is not as developed as it is in Ecuador. Most foreign tourism in Bolivia is centred on walking, climbing and skiing in the mountains, and visiting Lake Titicaca and cultural and historical sites. Ecotourism in the lowlands rain forests is less important, except for the Beni Biological Station.

In other Latin American countries, such as Costa Rica and Guatemala, ecotourism is a source of considerable foreign exchange. In Costa Rica, tourism — which is predominantly ecotourism — ranked second or third over the last few years as a source of foreign exchange and is increasing at a rate of 20 per cent annually (T. Budowski, pers. comm.). In 1989 tourism brought in almost US$ 200 million in foreign exchange (de Groot, 1992). In Guatemala the 350,000 tourists who visited there generated US$ 101.6 million in 1987 (Heinzmann and Reining, 1988).

Most of these statistics relate to non-consumptive forms of tourism. Big-game hunting has not developed in the Amazon region because of the difficulty in finding game and the lack of trophy species (Dourojeanni, 1985). In the upper Amazon region the few game hunters look mainly for spectacled bears. Jaguars and pumas and, to a lesser extent, tapirs and peccaries are hunted in the middle and lower regions.

Latin America does have a tradition of bird hunting, however (Robinson and Redford, 1991) and it is a popular sport. Bird-hunting safaris have been organised into Colombian Amazonia. There is very little implementation or enforcement of regulations for this hunting and information is scarce. About 200,000 ducks were hunted for sport in Venezuela in 1979 and 1980 (Fergusson Laguna, 1990).

Ecotourism can directly support conservation; for example, by funding park maintenance through entrance fees. In many countries, however, its full potential has not yet been realized. It has been estimated that the annual income from visitor fees to Ecuador's Galapagos Archipelago may be increased from $US 0.7 million (1986 actual figure) to $US 26.7 million. This is based on the same number of visitor days but a higher foreign visitor fee ($US 770, up from $US 40). In Costa Rica, income from visitor fees in Manuel Antonia, Poas and Cahuita national parks (290,000 vistors per year) could increase from $US 87,000 annually to as high as $US 234,000. Experience in other countries shows that when prices are increased, the number of visitors remains stable while revenue increases considerably (Lindberg, 1991).

Much of the income generated flows back to the central government, however, and is not necessarily used to maintain parks or related infrastructure (Lindberg, 1991). In order to make parks less susceptible to economic downturn, their income should be earmarked for nature conservation.

Ecotourism can also bring indirect economic benefits. It stimulates the souvenir industry; a survey revealed that tourists arriving by air to Guatemala spent an average of US$ 82 each on handicrafts. In Ecuador, Panama hats made of palm fibre are sold to tourists. An interesting development is taking place in Costa Rica, where Nature Shops (*Tiendas de la Naturaleza*) sell handicrafts and non-timber products to tourists (Fundacion Neotropica, 1990) as a means of generating income and of creating awareness of the value of the forest.

Economic importance of non-timber forest products

Export and production

Information on national production is not complete enough to allow for reasonable estimates or to compare the situations in different countries. Export data from the three countries in this study reveals that only a few products comprise the bulk of the export volume and value in each country. For Colombia, palm heart has recently become the most important export commodity; for Ecuador it is fibre products and for Bolivia it is Brazil nut.

Other countries have similar export patterns. Although no systematic survey of data from other countries has been made, some figures from Peru, Brazil, Venezuela, Guatemala and Belize have been collected (see appendix). The main export product in Peru is Brazil nut (Table 24). Harvesting totals are much higher than export totals, which suggests that there is a considerable internal consumption or illegal export (Table 24 and 25). Brazil has a large variety of products registered (Table 26), the most important of which are Brazil nut and palm heart. Chicle and ornamental plants are important export products in Belize (Table 29) while in Guatemala (Table 30) allspice and xaté are important.

Table 22 summarizes export data for 1985. In that year the total value of registered exports amounted to US$ 54,741,800 for the most important products. This figure only refers to officially registered exports. Table 18 provides a conservative estimate of the total export value in 1990 of non-timber forest products for several countries. It is based on available data and trends and includes estimates of non-registered exports. There are remarkable differences in export values between countries, which could partially be explained by inconsistent registration of one or more marketable products. For the South American rainforests as a whole, palm heart and Brazil nut have the highest export value (Table 22); these products are discussed in more detail in Chapter 7.

In 1986, the value of the export of non-timber products from Colombia was US$ 144,000, while the total value of exports for all forest products together was US$ 50 million (Motta Tello, 1988). This low relative value of non-timber forest products is probably the case in Bolivia and Ecuador as well.

Fluctuations in export and production

There are large fluctuations in the export pattern of many non-timber forest products. Products that have recently shown an increase in production and export are palm heart, in several countries, and Brazil nut in Bolivia. The importance of fibres is decreasing in Brazil. Certain fluctuations are difficult to explain, such as the peaks in the production of piassaba fibre in 1977 and 1979 (Tables 27a and b). Fluctuations could be caused by changes on the supply side, such as weather or disease, or by factors on the demand side like world market prices, legislation or fashion trends.

Patterns of production and export are not necessarily the same. In Brazil the production of juice from assai *(Euterpe oleracea)*, for example, has increased enormously in the last decade, but does not seem to have been exported (Tables 27a and b).

The export patterns of quinine and several gum species are remarkably similar. Production and export increased initially, in some cases rapidly, after the discovery of an important product or application. After some time, the monopoly of the wild product was broken by cultivated varieties, plantations were established in other parts of the world, and the countries of origin were not able to keep up with these developments. Depletion of a natural resource may also lead to a decrease in production.

Profitable non-timber forest production does not always lead to production on plantations. The reason for this can be biological: it might be difficult to grow the product on plantations, as is the case with Brazil nut; the production in natural stands is very high, as with palm heart; or extraction from natural stands might be cheaper than investing in plantations.

Furthermore, a country may wish to continue producing certain strategic goods even if it could buy those same goods less expensively on the world market. Such is the case with rubber in Brazil and quinine in Bolivia.

Table 12a. Export from Colombia: 1974-1982

	1974	1975	1976	1977	1978	1979	1980	1981	1982
volume (tonnes)									
balsam	270.7	3.9	4.2	6.8	5.4	1.8	1.6	1.2	1.3
palm heart	—	—	—	830.0	148.8	—	—	—	—
quinine	0.2	0.4	0.2	0.2	—	—	—	—	—
balata latex	16.4	0.7	8.2	8.8	—	—	—	—	—
gutapercha latex	< 0.1	—	—	—	—	—	—	—	—
value (US$ 1,000 FOB)									
balsam	222.3	128.7	100.9	157.9	116.5	50.3	57.5	50.5	49.6
tolu balsam	—	—	—	—	—	—	—	—	45.1
palm heart	—	—	—	878.6	165.1	—	—	—	—
quinine	4.2	11.3	9.9	13.2	—	—	—	—	—
balata latex	22.5	0.7	13.0	8.8	—	—	—	—	—
gutapercha latex	0.6	—	—	—	—	—	—	—	—
chicle	—	—	—	—	—	—	—	—	625.3
insects	—	—	—	—	—	—	—	—	—
total	**249.6**	**140.7**	**123.8**	**1,058.5**	**281.6**	**50.3**	**57.5**	**50.5**	**674.9**

Source: see Table 12b.

Table 12b. Export from Colombia: 1983-1991

	1983	1984	1985	1986	1987	1988	1989	1990	1991
balsam	1.2	< 0.1	1.2	0.8	0.7	0.4	0.1	—	—
palm heart	—	13.1	—	14.2	111.6	264.5	748.5	—	—
quinine	—	—	—	—	—	—	—	—	—
balata latex	—	—	—	—	—	—	—	—	—
gutapercha latex	—	—	—	—	—	—	—	—	—
value (US$ 1,000 FOB)									
balsam	43.3	2.0	45.2	33.7	36.5	21.0	5.5	—	—
tolu balsam	43.3	18.2	36.5	—	0.7	—	—	—	—
palm heart	—	28.9	—	19.8	202.5	500.3	1,455.6	2,600.0	*3,200.0
quinine	—	—	—	—	—	—	—	—	—
balata latex	—	—	—	—	—	—	—	—	—
gutapercha latex	—	—	—	—	—	—	—	—	—
chicle	216.3	37.2	19.3	78.7	55.3	—	—	—	—
insects	—	1.4	70.9	—	—	—	—	—	—
total	**259.6**	**69.5**	**135.4**	**143.7**	**294.3**	**521.3**	**1,461.1**	**2,600.0**	**3,200.0**

Sources: balsam, palm heart, quinine, balata latex, gutapercha latex: Delgado (1990); tolu balsam: Ramirez Perdomo (1988). These data have not been included in the calculation of total export value. Palm heart (value): Delgado (1990) for 1977-1989; Rincon (1991) for 1990 and 1991. Rincon (1991) gives a much higher figure for 1987(390.0) and much lower for 1989 (521.0); Ramirez Perdomo (1988) gives comparable figures for 1984, 1986 and 1987. Chicle, insects: Ramirez Perdomo (1988); see further explanation in the text. *estimate

Table 13. Production for 1990: Colombia

Non-timber forest products from some departments of Colombia's National Forest Estate.

product	quantity	department/region
palm heart	66,400 cogollos[1]	Pacifico Medico
yunce palm	4.2 tonnes	Llanos Orientalis
yare palm/liana	10.5 tonnes	Llanos Orientalis
piassaba fibre	509 tonnes	Llanos Orientalis
rubber	477 tonnes	Amazonas, Putumayo, Vaupes and Guaviare

Source: INDERENA, except for rubber: Ministerio de Agricultura (1990), data for 1984.
Notes: 1. A cogollo is the meristem of the palm, used as raw material for the production of palm heart; it is a pole about one metre in length.

Table 14a. Volume, export of non-timber products: Ecuador

	1981	1985	1990
volume (tonnes)			
palm heart	—	49.1	603.4
chicle, chewing gums	194.7	37.0	1.1
natural rubber[1]	—	6.3	—
other natural gums	4.1	—	—
toquilla and mocora fibre	0.8	7.4	7.5
totora fibre	2.0	—	—
articles of toquilla and mocora fibre	235.4	147.1	268.7
articles of totora fibre	—	0.1	—
bark of red quinine	1.0	—	—
bark of yellow quinine	90.1	39.0	—
bark of quinine, unspecified	—	61.5	—
condurango	25.0	18.4	8.0
tagua nuts and products	1,109.5	217.8	678.8
living animals, not for food	0.9	0.6	0.4
birds (mainly tanagers)	—	0.2	—
living ornamental fish	—	0.5	29.4

Source/Note: see Table 14b.

Table 14b. Value, export of non-timber products: Ecuador

	1981	1985	1990
value (US$ 1,000 FOB)			
palm heart	—	77.4	932.8
chicle, chewing gums	323.8	60.3	2.3
natural rubber[1]	—	7.7	—
other natural gums	5.6	—	_
toquilla and mocora fibre	9.0	3.7	7.7
totora fibre	2.0	—	—
articles of toquilla and mocora fibre	8,246.7	3,577.6	7,871.5
articles of totora fibre	0.7	1.8	—
bark of red quinine	0.8	—	—
bark of yellow quinine	100.4	36.8	—
bark of quinine, unspecified	—	48.7	—
condurango	—	19.4	4 2
tagua nuts and products	350.3	956.4	4,047.7
living animals, not for food	4.2	3.8	7 4
birds (tanagers)	1.2	1.4	—
living ornamental fish	0.5	46.1	—
total	**9,065.1**	**4,841.1**	**12,875.8**

Source (Tables 14a and b): Central Bank of Ecuador,
Note: 1. This figure is 30 per cent of the total rubber export; about 70 per cent of natural rubber is being harvested from plantations.

Table 15. Export of non-timber forest products: Bolivia

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
volume (1,000 tonnes)											
Brazil nut											
total	6.01	2.11	1.04	6.01	6.17	5.56	10.46	6.69	4.97	5.71	8.42
with shell	1.60	1.50	0.80	5.92	5.87	5.00	9.20	4.51	2.91	2.39	1.68
unshelled	4.41	0.61	0.24	0.09	0.31	0.56	1.26	2.18	2.06	3.32	6.74
rubber											
total	1.65	2.16	1.04	2.39	1.44	2.18	2.77	1.97	2.43	1.36	1.22
bolache[1]	0.69	0.33	0.14	1.47	0.27	—	0.60	12.15	—	0.21	—
laminada[2]	0.69	1.54	0.80	0.72	0.90	0.77	*0.67	*0.63	—	—	—
sernanby[3]	0.27	0.29	0.10	0.20	0.27	0.15	0.20	0.34	—	1.15	—
quinine	0.18	0.02	0.71	0.17	0.03	0.02	11.93	0.20	—	—	—
palm heart (tinned)	—	—	—	—	—	0.01	0.01	0.01	0.03	0.14	0.25
value (US$ 1,000,000)											
Brazil nut											
total	1.76	2.05	1.29	1.25	1.91	1.47	3.54	6.87	5.63	10.24	15.19
with shell	—	—	—	—	—	0.71	2.39	2.73	0.91	1.17	1.11
unshelled	—	—	—	—	—	0.76	1.15	4.14	4.72	9.07	14.08
rubber total[5]	4.6	3.4	4.1	2.8	0.8	0.53	2.01	1.85	2.25	1.27	1.44
quinine	0.09	0.02	0.12	0.05	0.01	0.00	2.58	0.21	—	—	—
palm heart (tinned)	—	—	—	—	—	0.01	0.01	0.02	0.05	0.28	0.50
total	**6.5**	**5.5**	**5.8**	**4.1**	**2.7**	**2.01**	**8.14**	**8.95**	**7.93**	**11.79**	**17.13**

Source: Instituto de Estadisticas (1989): data up to 1984 inclusive; data on specific rubber types up to 1987 inclusive; Mendoza(1991): data from 1985 onward.
Notes: 1. bolache = rubber balls; 2. laminada = flattened rubber; 3. sernanby = not dried with smoke but in open air, of lesser value than bolache; 4. Figures up to 1984 inclusive seem to be based on export data of "Brazil nut with shell" only; 5. Figures up to 1984 inclusive based on other export volume than in this table, namely: 1980 2.7 x 1,000 tonnes; 1981 1.7 x 1,000 tonnes; 1982 2.5 x 1,000 tonnes; 1983 4.0 x 1,000 tonnes; 1984 3.6 x 1,000 tonnes. These figures are derived from another table in the same source (Instituto de Estadisticas, 1989). * estimate

Table 16. Production of non-timber forest products, Bolivia

	1980	1981	1982	1983	1984	1985	1986	1987	*1988
volume (1,000 tonnes)									
Brazil nut (total)	10.54	3.76	1.04	22.11	7.38	5.99	11.39	15.83	14.27
with shell	6.13	3.15	0.80	5.93	6.99	5.61	10.28	12.63	8.97
unshelled	4.41	0.61	0.24	16.18	0.39	0.38	1.11	3.20	5.30
rubber (total)	2.83	4.09	2.20	2.71	3.25	3.71	4.84	41.70	29.98
bolache[1]	1.62	2.25	1.30	1.77	1.70	2.50	3.68	40.49	28.69
laminada[2]	0.84	1.54	0.80	0.74	1.28	1.06	0.94	0.87	0.81
sernanby[3]	0.37	0.30	0.10	0.20	0.27	0.15	0.22	0.34	0.48

Source: Instituto de Estadisticas (1989). For explanation of notes see Table 15. *estimate

Table 17. Monkeys

Estimate of number of monkeys hunted around Iquitos 1964-1974.

consumption: 10 years X 370,000/year	3,700,000
registered export	339,080
died before export: 2 per registered individual	678,160
unregistered export: 1 per registered individual	339,080
total	**5,056,320**

Source; Castro (1977).

Table 18. Export value

Estimate of total export value of non-timber forest products in 1990,

	export value (US$ 1,000)
Colombia	4,000–4,500
Ecuador	13,000–15,000
Bolivia	20,000–25,000
Peru	10,000-12,000
Brazil	50,000-55,000

Source: based on information in this report.

Table 19. Export of parrots and parakeets

Psittacine species (parrots, parakeets) exported from mainland neotropical countries

	1982	1983	1984	1985	1986	1988	1989
South America							
Bolivia	56,340	48,774	11,584	115	17	0	0
Brazil	27	30	47	16	75	—	—
Colombia	260	220	188	31	30	2	0
Ecuador	3,648	398	3,989	278	62	11	3
French Guiana	0	0	1	0	0	—	—
Guyana	26,693	25,300	38,177	27,386	30,324	—	—
Peru	39,303	19,463	51,671	33,921	16,997	—	—
Surinam	1,984	1,924	1,764	7,322	8,737	—	—
Venezuela	67	81	21	53	9	—	—
Central America							
Belize	13	29	7	15	41	—	—
Costa Rica	47	46	5	313	4	—	—
Guatemala	87	69	3,142	10,043	3,628	—	—
Honduras	6,501	9,253	14,483	17,164	14,769	—	—
Mexico	7,042	135	28	9	227	—	—
Nicaragua	100	121	96	282	1,827	—	—
Panama	184	101	55	50	54	—	—
El Salvador	877	552	1,388	2,065	16	—	—
Total	**143,173**	**106,496**	**126,646**	**99,063**	**76,817**	**13**	**3**

Sources: Thomsen and Brautigam (1991); on the basis of CITES annual reports; 1988 and 1989: World Conservation Monitoring Centre, also on the basis of CITES annual reports.

Table 20. CITES-reported export

Wildlife and wildlife products in 1986, 1988 and 1989

	live primates[1]			cat skins[2]			reptile skins[3]		
	1986	**1988**	**1989**	**1986**	**1988**	**1989**	**1986**	**1988**	**1989**
Colombia	2	2,748	326	2	0	0	0	66,884	5,400
Ecuador	—	0	2	11	0	0	—	3	66
Bolivia	361	0	0	6,124	0	0	97,922	93,708	0
Costa Rica	0	—	—	1	—	—	1	—	—
El Salvador	—	—	—	—	—	—	70,000	—	—
Guatemala	30	—	—	2	—	—	0	—	—
Honduras	1	—	—	2	—	—	4	—	—
Mexico	3	—	—	59	—	—	5,211	—	—
Nicaragua	13	—	—	2	—	—	113	—	—
Panama	—	—	—	—	—	—	123,120	—	—
Brazil	20	—	—	1	—	—	16	—	—
Guyana	5,305	—	—	3	—	—	52,333	—	—
Peru	311	—	—	4	—	—	2,852	—	—
Surinam	120	—	—	1	—	—	—	—	—
Venezuela	4	—	—	3	—	—	79,563	—	—

Source: 1986: World Resources Institute (1991), based on data of the World Conservation Monitoring Centre; 1988 and 1989: World Conservation Monitoring Centre.
Notes: 1. includes all captive-bred and wild-caught specimens of non-human primate species;
2. include skins of all species of *Felidae* (cats), excluding a small number of skins reported only by weight or length; 3. include whole skins, reported by number, of all crocodiles and many commonly traded lizard and snake species

Table 21. Registered export

Leather, skins and living animals from Latin American countries

	from	amount	to (if known)	period
leather				
deer[1]	Ciudad Bolivar, Venezuela	1,100,000		1856-1874
deer	Belém, Brazil	54,000		1898
white-tailed deer	Costa Rica	832,000		1900-1950
manatee	Amazonas	19,000		1930s-1950s
collared peccary	Iquitos, Peru	2,013,006	Europe and Japan	1946-1966
white-lipped peccary	Iquitos, Peru	848,364	Europe and Japan	1946-1966
caiman lizard	Venezuela	278,046		1980-1985
sea turtle	Latin America and Caribbean[5]	455,000	Japan	1970-1986
caiman	Latin America	3-4000/day	1930-1931	
caiman sclerops	Colombia	11,649,655	1951-1980	
crocodile	South America	2,593,834		1980-1984
skins				
giant otter	Peruvian and Brazilian Amazon	23,900		1960-1969
giant otter	Iquitos, Peru	22,644		1946-1966
river otter	"	90,574		
jaguar	"	12,704		
ocelot	"	138,102		
jaguar	Nicaragua	1,751		1966-1971
ocelot	"	17,157		
margay	"	21,473		
skins[2]	Colombia	1,960,100		1973

continued next page

	from	amount	to (if known)	period
skins (continued)				
cats: mostly ocelot and some jaguars'	Venezuela	3,802 4,171		1968 1969
	"	2,832		1970
	"	515		1977
	"	4,833		1978
	"	7,438		1979
	"	10		1985
	"	3		1986
living animals				
parrots	neotropics	703,000	United States	19814986
living animals[2]	Colombia	321,300		1973
primates	Iquitos, Peru	139,000		1961-1965
primates	"	91,662		1973
primates[4]	"	26,099		1971
carnivores[4]	"	1,173		1971
reptiles[4]	"	1,076		1971
batracios[4]	"	296		1971
rodents[4]	"	282		1971
tapirs[4]	"	4		1971
edemata: ant eaters, sloths, armadillos[4]	"	23		1971
birds	Peru	20,514	United States	1975
birds	Bolivia	481	United States	1970-1972
birds	Bolivia	24,251	United States	1979

Source: Redford and Robinson (1991), except for 1 to 5s
Notes:1. Source: Fergusson Laguna (1990); 2. Source: Patiño (1980), based on information of Regional Statistic reports of INDERENA. It is assumed that the data are related to wildlife. It is unclear whether "export" means from the administrative regions or from the country. 3. Sources: Fergusson Laguna (1990), quoting World Resources Institute (1988); for 1986: World Resources Institute (1990). 4. Source: Moro (1977), presumably all living animals. 5. Of which 75 % from Ecuador

Table 22. Exports, 1985

Export of most important non-timber forest products from South American countries in 1985

product	country	volume (tonnes)	value (US$ 1,000)
palm heart	Colombia	0.8	19.8
	Ecuador	49.1	77.4
	Bolivia	10.0	10.0
	Peru	[1]257.2	[1]425.4
	Brazil	5,136.0	10,220.0
gums	Colombia	n/a	78.7
	Ecuador	43.3	68.0
	Bolivia	2,108.0	530.0
	Brazil	1,148.5	3,793.3
fibres	Ecuador	154.6	3,583.1
	Brazil	383.0	475.0
tagua	Ecuador	217.8	956.4
Brazil nut	Bolivia	5,506.0	1,470.0
	Peru	[1]876.1	[1]1,598.7
	Brazil	25,915.0	25,155.0
tara	Peru	[1]3,544.4	[1]1,207.0
babassu oil	Brazil	5,671.0	4,258.0
barbatimao	Brazil	3,612.0	816.0
total			**54,741.8**

Sources: based on other tables in this report.
Notes: 1. data for 1981

Sustainable harvesting

Achieving sustainable development through the exploitation of non-timber forest products encompasses three factors:

- ecological components, which include the maintenance of the resource, the functioning of the ecosystem and the biodiversity;
- economic components, which include a positive cost-benefit balance;
- social, cultural and political components, which include the distribution of benefits, organisation of the exploitation, legal arrangements, etc.

Individual and community level

Extraction of non-timber forest products interferes with several processes:

- the life cycle of individual organisms: certain plant parts, such as leaves, can be harvested without destruction of the complete plant;
- the life cycle of populations of plants and animals. Extraction of other plant products, such as seeds and fruits, or of complete plants or animals, includes the removal of a individual from the population;
- food web relations and other biotic relations in the ecosystem;
- large scale and/or intensive harvesting may also effect soil and water conservation in the forest.

Appraising and measuring sustainability of these processes requires different approaches.

Effects of harvesting on individual organisms

Parts of the plant that can be harvested include fluids that are functional in the physiology of the plant, such as latexes and resins. As with the extraction of rubber (*Hevea spp.*) production can go on for years without destroying the plant.

Sustainability may depend on subtle characteristics of the species involved, however, as is shown in the the difference in extraction between *hevea* and *Castilla* (Chapter 5). Extraction may effect production of fluids, biomass production, phenology, etc.

Other components that can be harvested are those that are functional in the physiology and morphology of the plant, such as bark, leaves and fibres. Regrowth of these parts will take place as long as the physiological functioning of the plants is not hampered.

Extraction of plant parts will have an effect on the whole life cycle of the plant; for example, it might effect the production of biomass and seeds. The effect of the harvesting of leaves can be offset by compensatory growth. The net biomass production of the plant can increase after extraction, provided that the extraction level is modest and that the removal of the plant parts results in an increase of the net photosynthesis of the whole plant.

Analysis of phenology and of carbon and nutrient use by the different plant components can provide insight into the overall effect of extraction. In general, a modest harvest of plant parts should affect neither the survival and functioning of the plant nor the population or ecosystem.

Effects of harvesting on populations

Organisms can be harvested at different phases in their life cycle: mature or immature individuals, flowers, seeds, fruits or eggs. Sustainability of extraction depends on the renewal of the resource population being unhindered.

In general, extraction interferes with the population life cycle either at the beginning of the cycle (seeds or fruits) or at the level of mature individuals. Stable populations have a more or less triangular age structure; the number of younger individuals is higher than the number of mature ones. To maintain a stable population, mature individuals have to produce more offspring than their own number, since young individuals have an ongoing chance of dying and not all will reach maturity. The actual number of seeds, fruits and eggs is indeed much larger than the number of mature individuals and it might be assumed that there is a surplus of offspring to be harvested. In some cases, as with plants like Brazil nut or tagua nut, harvesting can be sustainable if enough seeds are left for natural regeneration.

Extraction of entire individuals does not automatically mean that the population size will decrease. It will affect the competition within a species. A decrease in competition, due, for example, to a lower density of individuals, might stimulate the total population growth. The rate of rejuvenation of the population would therefore be enhanced. Extraction of mature individuals from the population also means, however, a temporary decrease in the production of offspring. Therefore the removal of a mature individual has a similar effect to harvesting the offspring itself. This is compounded by the fact that the mature individual could have gone on to produce additional offspring.

In addition, harvesting a segment of the population may influence the process of natural selection. Animal populations may adapt to some extent to hunting pressure; for example, whales are known to mature and reproduce earlier when populations are threatened.

Experience with measuring the effect of harvesting on populations has been very limited. Few investigations have been carried out in tropical forests (Hartshorn, 1989; Sarukhan, 1978); most have focused on the effect of removing timber trees. Development of population models is underway, but refinement of these models is needed and their applicability has yet to be investigated (Usher, 1966 and 1969).

Effects of harvesting on the ecosystem

Even if harvesting of non-timber forest products does not threaten the products' populations themselves, it can have an effect on the forest. Harvesting of products changes the availability of certain food resources and affects functional processes in the ecosystem. Food resources or prey can be affected because of the extraction of seeds or eggs or by hunting activities (Redford, 1992).

Competition between species can change, and this in turn might threaten the biodiversity of the ecosystem. In spite of the high species diversity of tropical rainforests, there are many cases in which individual species play an irreplaceable role in the functioning of the ecosystem. Some plant species provide sustenance for animals in periods of food shortage. The extraction of keystone species — those which play a vital role in the functioning of the ecosystem or in the survival of other species — can have a severe impact on the ecosystem (Terborgh, 1989).

An interesting aspect of inter-species competition for non-timber forest products has been noted by Beckerman (1977). Barí Indians eat *Oenocarpus* and *Jessenia* palm seeds. The fruits are also eaten by birds, monkeys, peccaries and other animals that the Barí hunt for food. The Bari are thus in competition with their prey animals for palm fruits. The competition is not without its advantages, because when fruit is scarce, both the Barí and the animals are likely to converge on the same trees, thus simplifying the location of game. The fact that seeds are collected by the Barí works to their advantage; the fewer trees there are, the more likely it is that animals and man will come to the same tree at the same time.

Large mammals may also play an important role in the form of seed predation, seed dispersal and predation of other animals. Their absence might result in significant changes to the forest ecosystem (Redford, 1992).

It is difficult, however, to know the exact consequences of exploitation on ecological relationships. Competition within the ecosystem and the dynamics of this competition due to extraction of products are, as yet, poorly understood. It might be possible to describe and quantify these relations; it is much more complicated to simulate or predict changes in the food selection of a species, if the availability of its food resource were to decrease due to exploitation.

Large-scale removal of non-timber forest products might also affect the abiotic environmental factors of the ecosystem. If the forest canopy is opened by extractive activities, nutrients are removed that may also change the soil structure, hydrology and microclimate.

Extractive activities may also indirectly affect the ecosystem. For example, indiscriminate hunting often accompanies other extractive activities. Extraction sometimes promotes the development of an infrastructure and the colonisation of new areas, which may also have an impact on the ecosystem.

Management

Traditional management

The ecological effects of traditional Amerindian agricultural and forestry are still poorly understood (Gómez-Pompa, 1987; Dufour, 1990) and it is still unclear whether traditional use of rainforest resources is sustainable. The population density in the Amazonian forest has always been low, although it may have been higher in the past than at present (Dufour, 1990).

In traditional systems agriculture and forestry are closely associated and agricultural practices are adapted to obtain high production within the environmental constraints of the forest ecosystem (Posey, 1985; Padoch 1984; Padoch and de Jong 1989). Swidden agriculture as practised by Amerindians, with short cropping and long fallow, is considered a relatively benign disturbance and does not seriously impair the functioning of the ecosystem (Saldarriaga and Uhl, 1990). Forest regeneration during the fallow is considered key to the sustainability of swidden systems.

Amerindian forest management, through the selective removal of some trees and the protection and planting of others, appears to have a greater impact on species diversity than it does on forest regrowth in biomass (Saldarriaga and Uhl, 1990). For example, the Tukano Indians in the Vaupes region in Colombia open up one or two agricultural fields (*chagra*) every year, with a total size of 0.5 to 2 hectares. At any one time there are chagras in different phases: one recently sown with annuals (*biches*), one producing yucca and an old growth fallow (*barbecho*) along with a variety of fruit-producing trees and medicinal plants (Dufour, 1990).

Old growth fallow remains in use by the Indians. Agricultural fields also attract game animals, which feed on the crops. Uhl (1983) has suggested that heavily managed successions in areas like home gardens may grow to forest stature as fast or faster than natural ones. Recovery to primary forest in terms of biomass and species diversity may take 100 years or more, however.

Traditional systems of resource use are generally small scale and highly diverse and make use of subtle differences in the forest environment. Traditional forest-dwellers use a wide range of forest products and adapt their resource use strategies according to differences in soil and hydrology and between seasons.

The Kayapó Indians in Brazil's Amazon Basin divide their environment into a series of ecological zones. Agricultural plots, streams, forest stands and trailsides may form such zones. Trailsides and campsites are used for sowing certain species. Each zone is associated with a specific set of plants and animals. Concentrations of specific resources characterize certain ecological zones for the Kayapó. These concentrations reduce the heterogeneity of the forest to "resource islands" that can be periodically exploited for specific purposes (Posey, 1985).

The Desana Indians in Colombia also distinguish ecological environments, related at least in part to different animal groups. The Mayas also seem to have had very specific and efficient forest management techniques (Barrera et al. 1977; Gómez-Pompa, 1987). Not only Indians but non-Indian settlers (*caboclos*), who have been living in the forest for several generations, have developed a detailed knowledge of their environment and recognise up to ten different vertical zones in the forest (Posey, 1985).

Sometimes specific protection measures are part of traditional strategies for resource use and management. The flooded forest (*igapo*) is an important feeding ground for fish; consequently, the Indians have protected it from deforestation. On the other hand, there has been localized depletion of products such as cedar (*Cedrela odorata*) for canoes, palms for thatch and palm fruits (Vickers, 1988; Beckerman, 1977).

This depletion might be the result of a shift from a nomadic to a sedentary life style, as suggested by Anderson (1978). He notes that the rate of palm exploitation by the tribe he studied was far lower than that of many other South American Indians. He suggests that one of the reasons might be the scarcity of palms in the vicinity of the village. It is likely that some species like moriche (*Mauritia flexuosa*) and *Socratea exorrhiza* have been over-exploited during the relatively long period — at least 15 years — that the tribe resided in a particular place. The practice of cutting down the palms to obtain fruits and palm heart has definitely contributed to its scarcity. This pressure might explain why the Indians were traditionally nomadic.

The effect of indigenous hunting and fishing practices is also difficult to determine (Dufour, 1990). The only long-term monitoring of the effect of indigenous hunting on animal densities has been with Siona-Secoya Indians in Ecuador (Vickers, 1988). This showed that some animals would become rare locally while others would not. In general, it seems that certain species do not occur in areas where there has been no human interference. Some species, like tapir, deer and peccary, can reach higher densities in areas affected by human activity.

The effects on fishing are also unclear. The use of fish poisons, such as *barbasco,* may negatively affect the local fish populations, but the extent of this is not clear. The use of poisons was traditionally controlled by the shaman (Reichel-Dolmatoff, 1978) and restricted to small forest streams that could be temporarily dammed. The effects of these poisons appear to be temporary and highly localized (Dufour, 1990).

Commercial systems

Commercial rubber exploitation in Brazil was thought to be sustainable, since many rainforest areas had been occupied by rubber tappers for over 60 years. Some families had been on the same holdings for 40 or 50 years, with about 98 per cent of each holding remaining in natural forest. The mixed economy of the rubber tappers produces a surplus at the *seringal* itself, apart from the surplus obtained from the commercialization of latex. It does so without degrading the natural resource base. The effect of long-term occupation of the forests on biodiversity is unclear, however (Schwartzman, 1989).

In the case of the exploitation of assai, a palm species dominant in floodplain forest (*varzea* forest), specific management activities enhance fruit production. The Ribereños use selective thinning of forest competitors — vines and trees used for timber and firewood — and pruning of young juveniles and old adult stems to increase production (Anderson and Jardim, 1989; Anderson, 1990). A beverage is produced from the pulp of the fruit.

Not all commercial non-timber forest products are harvested and managed sustainably, however. In several regions of Amazonia during the 19th century, rapid depletion of the resources of commercial products occurred, such as several latex-producing species, quinine and *pashaco* (Dominguez and Gomez, 1990; Coomes, 1991). Rosewood oil was depleted after five years of exploitation in the Peruvian Department of Loreto (Coomes, 1991). During this century some palm species were regionally over-exploited even though non-destructive harvesting methods were available (Vasquez and Gentry, 1989). Heinzman and Reining (1988) did a preliminary survey on what they termed the reproductive health of the population of xaté. Their study took place in Guatemala, where harvesting pressure is high. When results were compared with Mexican studies, where harvesting pressure is lower, the preliminary conclusion was that exploitation was unsustainable because of the lower population density and flowering intensity in harvested areas.

Furthermore, it has been suggested that several larger vertebrate species have become ecologically extinct; that is, diminished to such a low density that they can not fulfil their role in the ecosystem. This is thought to be a result of commercial exploitation (Redford, 1992). Heavy exploitation pressure is not necessarily negative in terms of productivity, however, as Cornelius et al. (1991) showed. They compared the reproduction rate of olive ridley sea turtles at a protected site with the rate at an exploited site in Costa Rica. The reproductive rate at the exploited site appeared to be slightly higher, mainly because of the absence of large predators.

The exploitation of *babassu* palm in the southern Amazonian region is a special case (May et al., 1985a and 1985b). This palm is an exceptionally aggressive coloniser that can survive cutting and burning because of its method of germination. After germination, the apical meristem pushes itself into the ground where it remains protected until vertical growth commences several years later.

Cultivated lands that have been abandoned can be recolonized by high density stands of *babassu.* In dense *babassu* stands, shifting cultivators thin rather than clear-cut the mature palms. This allows sufficient light for cultivation of crops while assuring the production of forest resources during the subsequent fallow.

In the wetter portions of the *babassu* zone, formerly cultivated sites are being converted to improved pastures at an accelerating rate. This pasture conversion, together with the recent technology for industrial breaking and separation of babassu fruits, threatens the subsistence benefit of *babassu* (May et al.,1985a and 1985b).

Economic factors

The economic feasibility of the exploitation of non-timber forest products depends on the relation between supply and demand and the availability of alternatives. It has been suggested that a large quantity of new rainforest products can be marketed in western markets (Clay, 1992).

This, however, seems to be overly optimistic; an international market has only been secured for a relatively low number of non-timber forest products. The international market demands a regular and reliable supply, which might be culturally and biologically problematic. In order to ensure a regular supply of high-quality products, infrastructure, including transport, storage and processing facilities, needs to be set up and capital, knowledge and technology have to be made available (Harvard Institute for International Development, 1988).

In Colombia, Ecuador and Bolivia, government programmes exist or are being developed to increase the exploitation of non-timber products. If extraction of products appears to be profitable there will always be the tendency to domesticate these products, with agriculture and agro-forestry displacing extractivism.

This is illustrated by the case of chicle from Guatemala, used to make chewing gum and for a variety of medicinal purposes (Heinzman and Reining, 1988). The demand for Guatemalan chicle is low due to several factors:

- subsidized Brazilian chicle;
- a highly variable external market (the raw material can only be stored for a few months); and
- a lack of consistent quality.

Natural chicle must also compete with synthetic substitutes which, though of lower quality, taste and consistency, are uniform and free of impurities.

Making profitable extractive systems conform to sustainable management regimes might make them less profitable in the short term. On the other hand, by implementing some kind of resource accounting (see Chapter 4) sustainable extraction of non-timber forest products might become more profitable than other types of land use.

Often the comparison of profitability of various types of land use takes place in a distorted market. It has been argued, for example, that the major flaw of the extractive reserves system in Brazil is the price subsidy that protects traditional methods of domestic natural rubber production. The subsidy is in fact a tax paid by industry on imported rubber, which protects Brazilian rubber producers from lower world market prices (Schwartzman, 1989). Considerable income is generated through this tax, however. The rubber subsidy is relatively minor in comparison to subsidies to other sectors, such as cattle ranching, that compete for land in the Amazon. Furthermore, the exploitation of rubber from plantations may also receive financial support. For example, major rubber exporting countries like Malaysia, Indonesia, Thailand and Cameroon received World Bank support in the 1970s to develop rubber production.

The exploitation of non-timber forest products can provide significant employment and economic activity at regional and local levels. Harvesting, for example, is labour intensive. The regional economic importance of non-timber forest products is illustrated by the case of *babassu*. The fruit of the *babassu* palm is of great importance to the economy of the southeastern Amazonian region in Brazil. In addition to generating income from the sale of kernels or entire fruits to regional industries, *babassu* fruits are an important source of food and fuel for rural families. According to one estimate at least 450,000 families throughout Brazil harvest *babassu* fruits for extraction and sale of kernels (May et al., 1985a). Another example is the xaté industry in Guatemala, which provides employment for 8,000 individuals (Heinzman and Reining, 1988).

Social, cultural and political components

An important aspect of sustainability is whether extraction of non-timber forest products will combine with or compete with other economic activities of people living in the forest. Exploitation of non-timber forest products can contribute substantially to the income of rural people (Panayotou, 1991b) and is sometimes the only source of cash. The fact that many people are involved in the exploitation of non-timber forest products demonstrates its value, especially to those without an alternative way of earning a livelihood. Sustainable development means, however, that extractive activities require a certain degree of stability and independence; stability in revenue from products and in guarantees for land use, and independence in the control over the use of the resource. These conditions are often lacking.

Socio'economic relations

Often, but not always, the extraction of non-timber forest products forms only a part of the economy of rural people and is complemented by agriculture and livestock. Non-timber products are often the only source of cash income, however, as is the case with rubber tappers in Brazil. The economy of the autonomous rubber tappers is based on a combination of subsistence and market goods. The basic unit is a family or a group of families. Household subsistence is generated from small-scale agriculture and livestock, as well as hunting, fishing and gathering. Cash income is generated from rubber, Brazil nuts — up to 50 per cent of cash income — and babassu fruits. Extractive activities involve seasonal work and complement other economic activities carried out by rural households (May et al, 1985a). Local processing of non-timber forest products often consists of no more than drying, packing or tinning, and generally requires relatively little capital input. In some cases, technical improvement of harvesting and processing is also possible with small amounts of capital. Handicrafts involve the use of several products that require a low capital input but are labour-intensive.

Furthermore, extractive economies are often characterized by revenue from exploitation not being evenly distributed among the people who harvest the products and those who are involved in transport, processing and sale. Transport and trade are carried out by the same people; they also have harvesting rights or concessions and some capital, or are able to borrow money. Harvesters are dependent on the traders for transport.

Traditionally, the rubber tappers lived in a *seringal.* This consisted of the depot or headquarters of the patron (*barracão*) and the holdings or residence of the rubber tappers (*colocacões*). Although rubber tappers are generally no longer tied to a single patron for all transactions as under the traditional debt peonage systems, many rubber tappers are still in debt to intermediaries who advance goods and cash against future rubber production. Rubber tappers and other extractivists live some distance from each other, so organising them is difficult. Health care and educational facilities are expensive and almost non-existent (Fearnside, 1989).

This system of dependency and debt continues on the world market. International trade in palm heart and Brazil nuts is controlled by a few brokers.

Heinzman and Reining (1988) investigated the distribution of income derived from the extraction of palm leaves in Guatemala and discovered the following:

- 46-73 per cent of the gross benefits go to the 8000 harvesters;
- 12-28 per cent went to the 120 intermediaries; and
- 11-36 per cent went to the seven exporters in Guatemala.

In 1984 in Colombia the following prices were reported for the roots of *ipecacuanha* or *raicilla:*

- for the producer, US$ 20 per kilogram;
- for the intermediary, US$ 25 per kilogram; and
- for the exporter, US$ 50 per kilogram.

There is also an enormous difference in the price paid to the hunter for captured birds and the price that is paid abroad (Table 23). The price paid for monkeys in the United States is six to 13 times the price paid in the country of origin (Quevedo, 1977; Castro, 1977).

Culture

Extraction of non-timber forest products is part of the culture and tradition of various groups and there are cultural differences in the exploitation of these products. Rodriguez and van der Hammen (1991), in their study of the use of a river in the Colombian Amazon region, notice different perceptions of the environment on the part of recent colonists and Indians. This might partly explain the different exploitation systems between the two groups. Colonists use the river for commercial extraction of large fishes and turtles, while the Indians use it only to catch small fish for subsistence. For the colonists it is essentially unoccupied territory: a source of resources.

The Indians see the river space as part of the shamanistic territory, where every section has its owner. Forest management practices are regulated by symbolic models, rules and restrictions, which are laid down in the cosmology of the Indian community. The shaman plays a central role in this system by defining the obligations and rights of groups within a community. The symbolic models represent relations with the environment and natural resources (Walschburger and von Hildebrand, 1988). The sections that are being used for fishing, hunting, gathering, agriculture and living are well defined and are used according to patterns of annual events, climatic changes, hydrology, and fruiting of crops and wild fruits (Rodriquez and van der Hammen, 1990).

Important animal species have specific places in the cosmology that define their uses. The tapir, for example, is a representative from the ancestors within the cosmology of certain Indian groups; consequently its use is restricted. The Desana of Colombia have a system that establishes rules of compatibility, of what may be eaten, how, when and by whom. These prescriptions and restrictions form the foundation of an important network of behavioral rules (Reichel-Dolmatoff, 1989). Morales (1991) describes aspects of a similar system for Colombia's Cuna Indians.

Legislation and government policy

Management laws

Exploitation regulations are basically the same for Colombia, Ecuador and Bolivia. They comprise laws for natural resources, forestry and/or wildlife (INDERENA, 1977; Program Nacional Forestal, 1981; Centro Desarallo Forestal, 1975a en 1975b). Permits are needed for exploitation of non-timber forest products and require that the resource is maintained, whether it is in plantations or natural forest. In Bolivia the exploitation of bark for quinine is regulated by a separate law, because it is considered a strategic product. In general, there are different rules for subsistence use and for commercial exploitation. A tax has to be paid for the right to commercially exploit non-timber forest products. In Bolivia the *derecho de monte*, or wildland right, ranges from one per cent (Brazil nut) to ten per cent (palm heart) of the value of the product. There is unrestricted subsistence exploitation (*con la finalidad de atender las necesidades*) of edible forest fruits and of medicinal products used for home purposes. In Ecuador permits are required for subsistence use but no tax is imposed. The Ecuadorian government defines subsistence use as occurring if the product is not removed from the canton (pers. comm. Valencio).

Application of laws is a constraint. The government departments responsible are weak and have insufficient money, staff and knowledge to execute and enforce laws and regulations. In addition, taxes from exploitation of non-timber forest products are not being collected or applied to forest management (Vasquez and Gentry, 1989). In Ecuador, for example, permission is required for exploitation of non-timber forest products from the National Forest Estate, but only two out of 21 provinces have enforced this rule (pers. comm. Troncoso).

Although technically, hunting is permitted only with a licence, in Ecuador in 1987, only three individuals obtained licences out of an estimated total of one million hunters (Freiherr von Fürstenberg, 1987). It is therefore no exaggeration to state that hunting regulations are widely ignored. In Ecuador, fishing with toxic material or explosives is prohibited, but dynamiting and poisoning are common practices (Freiherr von Fürstenberg, 1987).

Land tenure

The history of the extraction *of* the bark of quinine is a typical example of the problems inherent in harvesting open access resources (Hardin, 1968). Extracting quinine bark always gave rise to a dilemma: choosing between felling the tree and taking the bark of the standing tree (Dominguez and Gomez, 1991). Partially harvesting the bark and covering the cuts with mosses, which prevents infectious diseases, carried the risk that other harvesters would take the bark that was left, or cut the tree down. Because of this risk, sustainable activities that were economically feasible were not carried out and the tree population was over-exploited.

Experiences with other products, such as latexes, suggest that a sedentary exploitation system with clearly defined land tenure might result in better management practices than systems that are not bound to one area.

Agricultural land reform programmes and land title programmes exist in almost all Latin American countries. Their object is to redistribute land to landless people or to those with small farms. Such programmes focus mainly on agricultural activities but, with some modifications, could be applied to extractive systems. An important disadvantage of some systems is the fact that the granting title and fiscal incentives are linked to the clearing of forest land for agricultural use.

In classifying public land, specific categories may be defined for the use of natural resources, including non-timber forest products. In Ecuador, for example, a Reserve for Faunistic Production may be established for economic use of wildlife. The area can be used for excursions for hunting or photography, hunting or capturing wildlife for meat, skins, living animals and other products. The legislation includes regulations for improved control of the managed wildlife population. Cuayabeno is at present the only area in this category (Freiherr von Fürstenberg, 1987). Ecuador also has proposed areas for hunting and fishing, with the objective of maintaining, promoting and harvesting wildlife for sports and recreation. To date no areas have been set aside.

In trying to combine rights to exploit non-timber forest products with the establishment of land use regulations, a third approach to granting legal status to extractive types of land use is the recognition of special rights for traditional communities. Indigenous communities in

Ecuador have the exclusive right to harvest products other than timber and wildlife on their own land. Similar rights are applied in the communal reserves in Peru (Pinedo-Vasquez et al, 1990) and Brazil (Anderson, 1990) and in the indigenous reserves (*resquardas indigenas*) in Colombia (Ruiz et al., 1993).

All these systems have elements similar to the Extractive Reserves of Brazil (see Chapter 1). As far as is known, however, Brazil is the only country in Latin America where there is an active government policy on establishing extractive reserves.

Table 23. Export of parrots

Estimated income from parrot species exported from neotropical countries

region and year	total number	estimated minimum gross income (US$)		
		trapper[1]	intermediary[2]	retailer[3]
South America				
1982	236,743	5,894,900	19,924,291	284,965,181
1983	243,788	6,070,321	20,517,198	293,445,178
1984	256,022	6,374,948	21,546,812	303,171,121
1985	268,007	6,673,374	22,555,469	322,597,345
1986	256,079	6,376,118	21,550,767	308,227,694
Central America and Mexico				
1982	14,851	369,790	1,249,860	17,876,000
1983	10,306	256,619	867,353	12,405,229
1984	19,204	478,180	1,616,209	23,115,663
1985	29,941	745,531	2,519,835	36,039,682
1986	20,566	512,093	1,730,835	24,816,787

Source: Thomsen and Bräutigam 1991,
Notes:
1 N=7 $X = 24,9 $ range = 2.5-65.0
2. N=25 $X = 84.16 $ range = 5.0-650.0
3. N=61 $X = 1,203.7 $ range = 37.5-9,000.0
N = 61 species represents a total sample of 310 prices for 61 species; when more than one price was found for a species, an average was used.

Brazil nut and palm heart

Brazil nut

Ecology

The Brazil nut tree *(Bertholletia excelsa)* can be found all over the Amazon basin and the Guianas on well-drained soils in areas with an annual rainfall between 1400 and 2800 millimetres (Salhuana Sanchez, 1973). Balée (1988) considers at least part of the Brazil nut forests as having been affected by human activities; pre-Colombian activities may have influenced their distribution (Müller, 1980). Kayapo Indians in Brazil plant Brazil nuts as a source of food for themselves and for the game they hunt (Posey, 1985). In natural forests the tree density of Brazil nut is variable and may amount to 15 to 20 trees per hectare (Salhuana Sanchez, 1973). Trees may occur in clusters of up to 100. Studies in Bolivia indicate that approximately 1.5 to 5 mature trees per hectare is most common (van Rijsoort et al. 1993). In natural forests the tree starts to fruit after 10 years. On plantations this can be shortened to five or even 3.5 years (Müller, 1982).

The establishment *of* Brazil nut in the forest depends on its germination and growth requirements. The number of seeds that will germinate may be low because of the complicated process that liberates the seed from the pod (UFA, unpublished data). About ten to 21 seeds are enclosed in a strong hard pod that drops between November to February. Seeds are released from the pod by animals, especially agoutis, or by decay.

There have been no specific studies on seed dispersal of Brazil nut, but studies on the seeds of *Gustavia superba,* which also belongs to the family *of Lecythidaceae,* showed that agoutis remove and bury significant numbers of seeds (Forget, 1992). After burying, it takes six to 18 months before the seeds germinate (Müller, 1980).

Dehydration inhibits germination (Müller, 1982); therefore, germination is most successful in the damp forest understorey and is also helped if the shells are removed or gnawed by animals (Zonta and Llanque, 1987). Light is required for growth to maturity (van Rijsoort et al., 1993); the tree is defined as a light-dependent gap specialist (Mori and Prance, 1990). Preliminary data suggest that, in secondary forest, more natural regeneration — that is, more plants of different sizes, and life stages — can be found than in primary forest (van Rijsoort et al., 1993).

Brazil nuts are produced almost exclusively from the natural forest. Plantations have had limited success and there are none in mainstream production. There are no significant plantations in Bolivia.

The low production on plantations is thought to be a result of the Brazil nut's complicated pollination biology. Although it has been suggested that the flowers can only be pollinated by large species of bees (Euglossine and carpenter bees), more recent evidence seems to dispute this (Nelson et al., 1985; Kitamura and Müller, 1984; Mori and Prance, 1990). Soil and climate may also influence production.

Economy

The Brazil nut has long been used as a source of food by Indian groups (Boom, 1987; Mori and Prance, 1990). Seeds are eaten roasted or raw or oil is extracted from them. Agricultural fields are often cultivated in the vicinity of Brazil nut trees. In this way, people can collect nuts with minimal effort.

The marketing of Brazil nuts only became important after the voyages of Von Humboldt and Bonpland in the 18th century. Regular extraction started at the beginning of this century (Patiño, 1980; Tables 25 and 26). The main use of nuts is confectionary; the oil is also used for cosmetics, soap and aviation lubricant. Brazil nut oil is being produced in Peru (Department of Madre de Dios), Bolivia (almost exclusively from the Department of Pando) and Brazil. It is now one of the most important non-timber exports from the Bolivian and Brazilian rainforests.

The main export of Brazil nut (INPEX, 1990) is to:

- the United States and the United Kingdom (40 per cent each);
- Australia (eight per cent); and
- Germany (two per cent).

The world export value of nuts in general has been increasing since the beginning of the 1980s. The Brazil nut has 1.5 per cent of this world market, for a value of about US$ 30 million per year.

The extraction of Brazil nuts shows sudden and extreme fluctuations, as does the world market price.

Brazil nuts are often used in mixtures and are easily replaceable. In the last five to ten years the production of Brazil nuts increased dramatically. In 1990 the price per kilo was US$ 1; this was inexpensive compared to other nuts, but that year supply outstripped demand. As a result world market prices declined and some processing plants had difficulties.

Until very recently, Brazil was the main producing and exporting country. Bolivia was the second largest producer although its officially registered annual production and export volumes during the 1980s fluctuated a great deal (Table 15). Biological factors may have affected these levels; in addition, nuts may have been kept in stock when prices were low.

The actual level of production in Pando was estimated to be much higher than the registered amount. There weren't enough processing plants in Pando; many of the nuts were therefore exported unregistered to Brazil and, to a lesser extent, Peru. In recent years, Bolivia's importance as an exporter of processed nuts has increased at the expense of Brazil. Production in Brazil has decreased due to deforestation, while in Bolivia processing capacity has increased. Bolivia became the main exporter in 1991 and export values continue to increase. The main production centres in Bolivia are Riberalta, through which 60 per cent of the trade passes, and Cojiba. About 8,000 seasonal workers and around 600 permanent workers are employed in the industry there (Driest, pers. comm.).

The extraction system in Pando, Bolivia

The Pando region was colonized for rubber extraction between 1894 and 1915 (Lopez, 1991). The collection areas are mostly large legal concessions, at the centre of which is the *barraca.* This is the house of the owner (*barranquero*), which is surrounded by a storage base, a few huts for the workers and a football-ground. From the barraca, paths lead to sub-centres for collection, a few involving travel of some days. From the sub-centres paths (*estradas*) lead to the trees. An *estrada* is the basic unit for the production of rubber; a *barraca* consists of many estradas. Alternately, in areas where families of independent rubber tappers or Brazil nut collectors have obtained legal title to the land, they own one or a few estradas.

Extraction is largely based on the traditional extraction system of rubber tapping (see Chapter 5). Formerly, rubber and Brazil nut were extracted in a combined system: rubber could be harvested during an eight- or nine-month period, and the rubber trees were able to recover during the three or four months that Brazil nut was harvested.

Little rubber is being tapped since the collapse of rubber prices in the mid 1980s. People left the region to look for work in places like Riberalta. During Brazil nut harvesting they return to the forest. Nuts are harvested from the end of October to the end of January. They have to be collected quickly to prevent water from entering the pods through the hole in the pericarp. In Peru harvesters first turn the pods upside down so that water cannot enter; they return later to collect the seeds.

The pods are cut open and the seeds are collected in the forest. They are temporarily stored at the *barraca,* transported to the processing plant by river and stored again in the plant. Usually the nuts are shelled manually in large processing plants (*beneficiadores*), where children, elderly people and temporary labourers can make some money. One third of the legally exported nuts are shelled. Most processing takes place in Riberalta, which has over ten plants. It is the single most important business in Riberalta.

Traditionally the *barranqueros* were key to the economy of the extraction system. They owned the legal concessions and processing plants. The collectors are dependent on loans from the *barranquero* for their income. Loans are paid off in Brazil nuts. *Barranqueros* also sell provisions at the *barraca* at prices much higher than in Riberalta and other towns. Workers are often in debt to the *barranquero,* similarly to the situation in timber and rubber exploitation (Ros-Tonen, 1992; Schwartzman, 1989). Brazil nut collectors receive only a small proportion of the overall profit. The following breakdown applies to the price paid for Brazil nuts leaving Bolivia:

- about 67 per cent is destined for the processing plant;
- 15 per cent goes to post-processing transport;
- nine per cent goes to collectors in the forest; and
- nine per cent goes to transport from the forest to the plant (Mendoza, 1988).

Production is still concentrated in a few hands (Emmi, 1988), although land reforms have changed this situation slightly. Ormachea and Fernandez (1986) studied ownership of Brazil nut production. They made a distinction between two types of economic units. *Barracas* are owned by *barranqueros,* who employ people to harvest the estradas; while in family units, family members harvest one or a few estradas. In 1984 they found that 75 per cent of the traditional *estradas* in Pando were still part of *barracas,* which made up 52 per cent of the total number of economic units (barracas and family units). A few very large *barracas* exist: 31 per cent of the estradas belong to 1.3 per cent of the economic units.

Where road access exists the percentage of small family units is higher. Transport by road to the processing plant is easier and cheaper than by river, making it easier for the workers to organise themselves and work more independently. A similar situation can be seen in the extractive reserves in Brazil.

The wood of Brazil nut trees is utilized as well, although laws in Brazil and Bolivia favour the long-term benefits of nut extraction over the short-term benefits of timber exploitation. It is forbidden to cut down Brazil nut trees, although when the forest around the trees is destroyed, nut production diminishes and the tree will then be cut.

Sustainable harvesting

For decades, Brazil nuts have been harvested in large quantities from the Bolivian rainforest. The human population density is still very low; deforestation is limited to about one to two per cent and is confined to small agricultural plots or *chacos* (Alexander, 1989). When Brazil nut is not being harvested, people harvest rubber, work on their *chaco,* maintain the *barracas* or work in the processing plants in Riberalta.

The existing land use seems to be sustainable, although two factors might change this:

- Pressure on the land and subsequent deforestation may increase through migration. Two groups migrate into the sparsely-populated Pando: Bolivians from other regions and illegal Brazilians (up to 25 families per day). Deforestation on the Brazilian side of the border is already much higher than in Bolivia. Bolivian barranqueros are also converting forest into pasture for cattle ranching.
- Pando's potential production of Brazil nuts is much higher than existing production. The potential production has been estimated at 35,000 to 40,000 tonnes per year, roughly twice as high as existing production (Alexander, 1989). Yet, market prospects are uncertain: some say that the global market is saturated and that the production of Brazil nuts is too high; others claim that new initiatives by The Body Shop and other retailers promise an increase in demand.

Natural generation of the Brazil nut tree seems to be limited in exploited areas; an increase in human exploitation may worsen this (van Rijsoort, et al., 1993). Harvesting Brazil nuts involves removing the seeds. It might be expected that the extraction of Brazil nuts from the forest would not affect the ecosystem, since the tree produces a lot of seeds and trees in general produce a surplus of seeds (Chapter 7). The germination process of the Brazil nut is complicated, however, and in natural conditions only a few will germinate. If most of the seeds are extracted, the number of seeds available for germination will decrease.

Exploitation is accompanied by hunting of agoutis. These animals open the pods and consume the seeds; by opening the pods, the agoutis allow the remaining seeds to germinate. A decrease in the number of agoutis and in the availability of seeds for germination due to human exploitation may hinder natural regeneration. Extraction activities could possibly increase the amount of liberated seeds, however, if people who collect the seeds also open the pods and leave some nuts on the forest floor (van Rijsoort et al., 1993). Unfortunately, there is not enough information available to compare the situation with that at an unexploited site.

Extraction can affect food relations within the forest as well as population densities of trees. Collecting the nuts also means removing food resources from animals that feed on these nuts. Although only a few species feed on Brazil nuts, these species may be directly affected by human extraction.

The ecosystem will be indirectly affected by extraction activities as well. Collectors also participate in agricultural and other extractive activities, which have been increased by the infrastructure developed for Brazil nut collection. Until now, agriculture has not presented a serious threat to the ecosystem, but that may change.

One option for improved management of Brazil nut exploitation is enrichment planting in the forest adjacent to the communities and still within the natural forest. In this way, extraction can be concentrated in these areas, the infrastructure is used more efficiently and the pressure on the more remote forest can be kept low.

The sustainability of the exploitation system also depends on the socio-economic status of the harvesters. There are several ways to improve their standard of living:

- development of small scale agriculture near the communities;
- involving the collectors in processing in the factories;
- improving wages and working conditions; and
- stimulating other extractive activities, such as rubber tapping, small scale timber exploitation, handicraft, ecotourism, etc.

As a result of this study, research projects have evolved to develop management plans for multiple use of the forest. One study will focus on the current socio-economic status of several groups of collectors of Brazil nut in the Amazon region. It will study their income and debt as well as other dependency relations. It will make recommendations about the organisation of the production system of Brazil nuts as well as agricultural activities that are economically feasible.

Additional knowledge about the germination and growth of Brazil nut is needed for estimating the maximum number of seeds that can be harvested in the long term and for recommendations about enrichment planting. A research program was developed by the University of Beni in Riberalta (UFA), Utrecht University and the Netherlands Committee for IUCN. This program will be carried out in the forest in northeast Bolivia.

The program will develop a population transition model to simulate and calculate population growth rates in the long term. Basic knowledge about the population biology and ecology of the species will be collected. It will include population structure in relation to forest structure, seed production and dispersion, and germination and establishment of the species.

These studies will be accompanied by experiments with enrichment activities in the natural forest. The findings will be incorporated in the forest management plan.

Palm heart

Ecology

Palm heart is produced from several palm species, such as peach palm (Bactris *gasipeas, pejibaye* or *chontaduro), Astrocaryum jauani* or *murumuru,* but the main sources are several species from the genus *Euterpe: E. edulis, E. cuatrecasana* and E. *oleracea* (Delgado, 1990; Arce, pers. comm; Mendoza, 1991).

An important producing region is the Chocó, a bio-geographical area along Colombia's Pacific coast and separate from the Amazon region. The Chocó is thought to be one of the areas of exceptionally high but threatened biodiversity (Myers, 1988a). Palm heart exploitation in the Chocó is concentrated in the Department of Nariño in southwest Colombia. E. *cuatrecasana,* locally known as *ruddí,* and *E. edulis* are being exploited.

The natural vegetation of the Chocó is determined by its location west of the Andes, isolated from the Amazon and Orinoco catchments. This vegetation varies from the seashore to the foothills according to rainfall, hydrology — influence of tide, salinity and inundation — and soil types. *Naidizales,* the vegetation type in which *naidí* is dominant, occurs in intermediate situations. The soils of the *naidizales* are inundated periodically or almost permanently. *Naidí* can tolerate some salty influence but does not mix with mangrove species in the outermost seashore lines. It is a pioneer species and can quickly colonize new areas in the highly dynamic system in which it lives: currents of rivers are constantly changing, taking land away and creating new land.

The total area of *naidizal* has been estimated at around 90,000 to 100,000 hectares (Arbelaez, 1991), including secondary and mixed stands: *naidí* can be found in association with several other tree species (known as *guandales* and *natales*). Although the density of palms in monostands can be very high — more than 60,000 palms per hectare (Arbelaez, 1991) — there can also be high biodiversity. Herb species seem to grow especially well under the palm vegetation.

Naidi is a clonal species, which means that one plant or genet has several shoots or ramets of different ages. After one or more ramets are cut, the genet produces new ramets with the support of the existing ones. Regeneration can be either generative (seeds) or vegetative (ramets). Fruiting can take place twice a year. One sprout may produce six clusters with around 2,000 fruits each (Arbelaez, 1991). In contrast, exploitation of palm heart from E. *edulis* kills the individual plant, which has only one stem. Due to over-exploitation, this species is almost extinct in the south and southeast of Brazil.

Economy

Palm heart is exploited in Brazil, Bolivia, Peru, Venezuela, Ecuador, Colombia and Central America. Large-scale commercial production started only a few decades ago but is increasing rapidly. Exploitation is prone to the same fluctuations as other non-timber forest products, like rubber and Brazil nuts. Prices for the collectors have decreased dramatically during the last few years.

The first export of *naidí* from Colombia was registered in 1977. In the following year the government restricted exports until more information was available about its rational exploitation. From 1984 to 1986 exports were not significant. Between 1977 and 1987, Colombia's average annual export earnings from palm heart were US$ 202,500. Export volume and value have increased rapidly since then. Palm heart is Colombia's most important non-timber forest product.

In 1991 there were seven canning factories in Colombia, six of which were exporting. The exploitation of palm heart has generated direct or indirect employment for about 1,000 workers. Annual production capacity is 2,210 tonnes, 50 per cent of which is utilized.

The extraction system in Nariño, Colombia

Harvesting of palm heart is carried out by people who live in the region. The workers sell the raw material (*cogollos*) on the riverside to intermediaries or to representatives of the processing company. The factory can also employ workers on its own concessions. The people are not involved full time in harvesting but instead combine it with agriculture and other activities. The *naidizales* are used by inhabitants for fishing and hunting and the fruits of *naidí* are consumed locally. The exploitation of *naidí* is by far the most important economic activity, however, having surpassed timber exploitation in the 1970s (CONIF, 1990).

There are different phases in the exploitation of palm heart (CONIF, 1990):

- selecting palms to be harvested;
- "liberation thinning" of ramets which are not valuable and which hinder the workers in cutting harvestable ramets;
- cutting the ramets, and cutting and peeling the harvestable part of the ramet. The actual palm heart is the meristem of the palm, situated in the top of the ramet and protected by the leaf-sheaths. The resulting raw material (*cogolb*) is a pole about one metre long and several centimetres in diameter. Different techniques for cutting are used: in some places one or two large ramets are left in the genet to enable them to set fruit. In other places all the mature stems are cut;
- transport of the *cogollos* to the riverside, often with the use of canoes; and
- transport to the processing plant, peeling the remaining leaf stems and tinning.

Tinning takes place in the region itself. Transport to the tinning factory is by boat and most harvest areas are within one day of the factory. Transport is still the main reason for loss of production, because *cogollos* can only remain untinned for a few days and the collecting boat does not always pass frequently enough to prevent them from spoiling. Losses of up to one third of the harvest have been reported.

Without any management plan or restrictions, the area will be exhausted within several years. The regional development cooperation (*Corponariño*), the local government and the federation of palm heart processing industries realise that in the long run, development and nature conservation will be threatened if no restrictions are put in place. Establishment of plantations is not likely, as natural stands produce nearly the same amount as plantations.

Sustainable harvesting

Production of palm heart from *ruddi* is important for the economic development of the region. *naidí* is an export product that can be processed in the area where it is grown and harvested. This means that some added value remains in the region. *Naidí's* clonal growth suggests that reproduction and regrowth after harvesting can be very efficient.

The *naidizales* are being threatened by conversion to agricultural land and, even more, by over-exploitation. It has been estimated that about 40 per cent of the original area of *naidizal* has been severely disturbed and only 24 per cent has been disturbed slightly or not at all (CONIF, 1990).

The exploiting companies and local authorities have noticed a decrease of available raw material. In theory, the companies have to present management plans before they can obtain a concession, but these plans are quite cursory. There is a lack of knowledge about the state of the *naidizales* from which the companies collect *cogollos* along the rivers. Non-compliance with the law is not restricted to Nariño. In Ecuador, for example, the actual export volumes often exceed the quota set by the Central Bank. In 1990 the national annual allowable cut of palm heart was 9.8 tonnes, compared with an actual registered export of 593 tonnes (Table 14).

There are two directions for future exploitation: rational silvicultural exploitation of natural stands of *naidí* and planting of *E. oleracea* (Rincón, pers. comm.). Because of a lack of information, industry has not yet decided which strategy will be better. The body in charge of management of natural resources, *Corponarino,* is developing a land-use plan for the region. Corponarino recognized the value of certain areas for the protection of biodiversity and established some nature reserves in which extraction is prohibited. Land tenure is still unclear in the region and has to be settled as part of a land-use plan. For the exploitable areas, management plans are required and are being developed in cooperation with the industry and with specialized institutions like CONIF.

In developing these management plans, industry is conducting some applied research on the growth of the species and on the effect of fertilization. The local government, *Corponarino* and CONIF invited Utrecht University to develop and execute a joint research program which can contribute to the technical and social-economic organisation of production.

In order to develop a model for optimum production, more information is needed about the growth characteristics of *naidi.* There is little knowledge about the growth or regrowth habits of this clonal species. The layered position of the ramets within the total genet indicates that there is no continuous length growth or continuous sprouting of ramets. The species has a phalanx strategy; that is, ramets sprout and grow in "cohorts" close to the genet. Due to this clonal growth it can be hypothesised that harvesting of sprouts from the clone will enhance the net biomass production. New sprouts are supported by the older ones, but it is not clear to what extend this integration within one genet is developed at a physiological level. This is important for the selection of the harvestable ramets. It is supposed that an optimum rate for the maximum net biomass production and thus the harvest level exists between the amount of harvested ramets and those that are left. As a result of the physical structure of the genet, light climate effects growth and resprouting.

Conclusions and recommendations

There is a growing interest in the commercial exploitation of non-timber forest products from rainforests among forest-dwellers and policy makers. This interest arises from the need to develop strategies to conserve the rainforest and from growing recognition of the traditional rights of forest-dwellers.

Extractive reserves

Brazil and Peru are the only Latin America countries that have legal mechanisms to preserve rainforest areas specifically for the exploitation of non-timber forest products. The extractive reserves in Brazil were established to safeguard rubber resources and combine the objectives of conservation and development. The sustainability of the extraction of non-timber forest products in these reserves has not been evaluated, however.

Value of non-timber products

Non-timber forest products have both a subsistence value and a market value. The subsistence value is especially important to people without many cash resources, since the products are often available free of charge.

Animals are an important source of protein, while plants provide construction material and medicine. Non-timber products also have important cultural uses. In addition, commercial exploitation generates cash income at local, national and international levels.

The main products from Colombia, Ecuador and Bolivia in the international market are palm heart, Brazil nut, tagua, palm fibres and gum. Bolivia and Ecuador have higher total export values than Colombia.

Many products are used for subsistence but not marketed commercially. The reasons for lack of market development include lack of infrastructure, limited technology, lack of access to markets and unfamiliarity with products on the part of consumers.

The commercial exploitation of non-timber products must be stimulated by creating new markets for existing products and by improving market structures and facilities.

Assessing value

The usual method of valuing non-timber forest products does not include their total worth but represents only their monetary value. A sustainable extraction system also enhances other forest values, such as cultural values.

The long-term benefits of sustainable extraction should be considered when placing a value on non-timber products. Maintaining the forest is achieved more easily through sustainable exploitation than by other types of land use.

Ecotourism

Ecotourism can generate considerable income, both locally and nationally. Its full economic potential has not yet been realized in Latin America. Income from ecotourism can be increased by creating new facilities and increasing fees for existing facilities, and should be used for conservation and development.

Other land use

The exploitation of non-timber forest products can be the most profitable use of the rainforest. Rainforests are still being converted to agricultural land; however, for the following reasons:

- newcomers clear land for agriculture because they have limited knowledge of sustainable land use;
- land title, credit and fiscal policies often favour clearing land; and
- short-term income from other land uses is generally higher.

Brazil nut and palm heart

Although in theory, the exploitation of non-timber products can be managed in a sustainable way, in practice, resources have often been over-exploited. Over-exploitation is partly related to the type of lives led by local residents; generally, the more sedentary the life, the better the management. There has still been considerable forest destruction in some extractive reserves in Brazil, however, even with inhabitants living sedentary lives.

There is not enough information about sustainability, even for important products like Brazil nut and palm heart. Brazil nuts have been harvested for many years, although exploitation has intensified in the last few decades. Models for population growth and dynamics have been developed for tropical tree species, but these types of studies have not yet been applied to Brazil nut.

The effects of intensive exploitation will only be fully understood in the long term. It is known that increased harvest levels limit regeneration; furthermore, exploitation generates secondary activities such as hunting. Harvesters of non-timber products often carry guns and hunt on their way to and from the harvesting area.

In southwest Colombia, extraction of palm heart is carried out in a destructive way and resources will soon be depleted. This is an area with a high but poorly-understood biodiversity; there is limited information about growth, effects of cutting and the ecosystem. The development of management plans is still in the initial planning stage.

It is necessary to establish maximum sustainable harvest levels in order to develop sustainable exploitation systems. This must include an evaluation of the effects of harvesting on individuals, on other species and on the ecosystem in general. Management plans must be developed that utilize this knowledge.

Socio-economics

The exploitation of Brazil nuts in northern Bolivia and palm heart in Colombia is important to regional economies. The export value of these products has increased rapidly since 1985 and there are plans to further increase production. Exploitation systems are unstable and socially inequitable for the following reasons:

- people in the field often work under a debt peonage system and are financially dependent on concession owners;
- working conditions are harsh and wages in the processing plants are low; and
- health care and education are often lacking in remote areas.

Improving harvesters' socio-economic situation can be achieved by granting them land tenure, and by improving facilities for transport, processing and marketing. Governments can contribute by developing management guidelines and promoting health care and education.

Domestication

Often, extractive products with a commercial value are domesticated and grown on plantations, as is the case with rubber and quinine. This is not always possible, however, for the following reasons:

- in some cases, as with rubber in certain regions and with Brazil nut, domestication is technically difficult or impossible;

- it is not profitable (as is the case with plants such as palms, which occur in monostands) or the high investments necessary do not outweigh the advantages of low labour costs.

It may be appropriate to develop an intermediate strategy. For example, enrichment planting can be beneficial and still be an appropriate conservation step.

Conservation and development

Total protection can be, in certain cases, an appropriate strategy to conserve biodiversity. Given the current situation and conflicting claims on forest resources, however, it is unlikely that enough forest land will be set aside. The sustainable extraction of non-timber forest products seems to offer a viable alternative for certain areas, providing it is well managed and generates adequate income. Sustainable extraction can save habitat, contribute to production and maintain forest function.

Land use plans must be developed. These should include managed areas, like buffer zones, to allow for sustainable exploitation. Enrichment activities may enhance the viability of these extractive areas.

Endnotes

1. Ecotourism has been defined as: "That segment of tourism that involves travelling to relatively undisturbed natural areas with the specific object of admiring, studying, and enjoying the scenery and its wild plants and animals, as well as any existing cultural features (both past and present) found in these areas" (Ceballos-Lascuraín, 1992). There is no strict distinction between traditional tourism and ecotourism (Ziffer, 1989), either in definition or in the way tourists behave. People visiting nature parks also want to spend some time at the beach or visiting cultural institutions. Scientific activities might be included as well. Scientific field stations can generate considerable income for the maintenance of natural areas.

2. The objective of Protected Areas in category VIII is defined as: "to provide for the sustained production of water, timber, wildlife, pasture and outdoor recreation, with the conservation of nature primarily oriented to the support of economic activities (although specific zones may be designed within these areas to achieve specific conservation objectives)".

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Appendix

Table 24. Export of non-timber forest products, Peru

	1978	1979	1980	1981
volume (tonnes)				
Brazil nut	1,169.7	1,068.7	1,431.9	876.1
curare	13.8	—	—	—
barbasco	807.7	16.0	333.4	38.3
tara/dividivi	3,921.0	10.3	2,823.5	3,544.4
palm heart	384.4	—	—	257.2
bark of quinine	—	—	—	25.4
total	**6,296.5**	**1,095.1**	**4,588.8**	**4,741.4**
value (US$ 1,000)				
Brazil nut	2,040.1	9,425.4	2,342.6	1,598.7
curare	159.4	—	—	—
barbasco	526.3	9.6	227.4	28.0
tara/dividivi	837.4	4.7	839.6	1,207.0
palm heart	435.3	—	—	425.4
bark of quinine	—	—	—	40.4
total	**3,998.4**	**9,439.6**	**3,409.6**	**3,299.5**

Source: Dirección General Forestal y Fauna (1982).

Table 25a. Non-timber forest products, Peru: 1978-1983

	1978	1979	1980	1981	1982	1983
volume (tonnes)						
moriche	—	—	72.5	446.4	287.4	102.9
locust	8,252.3	8,814.0	9,723.9	836.3	8,137.0	340.8
brave cane	—	—	370.6	935.0	603.5	104.9
Brazil nut	3,073.4	4,143.3	4,321.2	1,211.8	3,503.9	4,836.1
barbasco	1,768.9	—	679.6	—	652.1	—
natural rubber	—	—	439.9	292.9	856.1	422.7
palm heart	403.6	161.3	501.8	1,906.6	513.1	—
ratania	—	—	5.0	21.0	—	—
tara en vaina	8,234.0	5,609.1	1,726.2	2,368.2	5,363.1	2,706.7
bark for quinine	3.4	0.5	—	—	—	—
curare	278.0	41.8	—	—	—	—
ojé latex	9.1	13.1	—	—	—	—

Source: see Table 25b

Table 25b. Non-timber forest products, Peru: 1984-1989

volume (tonnes)	1984	1985	1986	1987	*1988	*1989
moriche	301.4	158.3	213.8	44.3	44.5	—
locust	1,006.8	1,606.4	5,800.9	—	14,600.0	—
"brave cane"	659.1	888.4	1,777.3	261.7	47.6	—
Brazil nut	4,193.1	2,622.9	3,985.9	2,557.4	3,021.8	3,020.5
barbasco	90.5	1,370.8	313.8	—	—	—
natural rubber	579.9	59.2	87.5	49.8	7.6	31.4
palm heart	54.7	85.9	58.8	103.1	105.6	—
ratania	5.0	1.2	0.8	—	—	—
tara en vaina	4,161.9	5,555.3	6,435.3	3,650.0	1,980.9	2,511.9
bark for quinine	—	—	—	—	—	—
curare	—	—	—	—	—	—
ojé latex	—	—	—	—	—	—

Sources (Tables 25a and b): Dirección General Forestal Y Fauna (1982); Dirección General Forestal Y Fauna (1990) for data after 1979. *estímate

Table 26. Export of non-timber forest products: Brazil

	1975		1985		1989[1]	
	volume tonnes	value US$ 1,000	volume tonnes	value US$ 1,000	volume tonnes	value US$ 1,000
latex.						
sorva	—	—	1,138.0	3,775.0	—	—
balata	—	—	4.6	10.0	—	—
massaranduba	—	—	5.9	8.3	—	—
edible/drinks						
Brazil nuts	6,256.0	3,844.0	25,915.0	25,155.0	13,361.0	21,290.0
palm heart, tinned	156.0	187.0	5,136.0	10,220.0	5,448.0	19,349.0
oils/aromatics						
babassu residues	4,441.0	362.0	—	—	—	—
babassu oil		—	5,671.0	4,258.0	115.0	109.0
copaiba	10.0	23.0	50.0	125.0	62.0	250.0
oiticica oil, refined	—	—	51.0	36.0	—	—
oiticica oil, cooked	—	—	17.0	16.0	—	—
cumaru	0.7	1,7	46.0	382.0	40.0	152.0
palmarosa	0.7	11.0	—	—	—	—
rosewood oil	0.2	1.8	39.0	714.0	76.0	2,085.0
sassafras oil	—	—	—	—	*1,500.0	n/a
fibre						
piassaba	161.0	160.0	383.0	475.0	—	—
medicinal						
jaborandi	5.6	8.9	18.0	55.0	—	—
tonka beans[2]	—	—	n/a	365.0	—	—
colouring agents/tannins						
barbatimao	—	—	3,612.0	816.0	—	—
waxes						
carnauba	780.0	1,461.0	—	—	—	—
urucuri	—	—	5.0	19.0	—	—
total	**n/a**	**6,060.4**	**n/a**	**46,429.3**	**n/a**	**43,235.0**

Source: Richards (1992), except for: 1. 1989 data is January to November only; 2. Tonka beans: Prance (1989); *estimate.

Table 27a. Volume of non-timber forest products, Brazil

	1976	1977	1979	1982	1986	1987
volume (tonnes)						
latexes						
rubber	16,000	—	[4]21,560	26,800	28,400	26,400
mangabeira	—	—	20	—	—	—
sorva	6,200	—	5,200	5,500	3,000	1,500
balata	510	—	360	220	20	20
chicle	—	—	10	—	—	—
massaranduba	510	—	440	430	380	300
caucho	320	—	990	910	200	90
waxes						
carnaúba	—	19,074	19,920	—	—	—
edible/drinks						
Brazil nuts	61,000	—	43,240	36,400	35,600	36,200
assai juice	18,700	[5]53,623	[5]54,510	80,900	133,800	145,900
palm heart	197,700	35,123	31,360	95,100	124,300	138,900
mangaba	—	—	1,100	—	—	—
oils/aromatics						
babassu oil	174,000	236,755	250,910	—	—	147,300
copaiba oil	30	—	30	70	40	110
cumaru	20	—	40	50	460	330
licuri	—	—	—	—	—	3,800
urucuri	—	7,364	—	4,200	4,600	—
crabwood	—	—	280	—	—	—
murumuru	—	29	20	—	—	—
ucuúba	—	—	80	—	—	—
star-nut palm	—	8,556	11,720	—	—	—

continued on next page

(continued)	**1976**	**1977**	**1979**	**1982**	**1986**	**1987**
volume (tonnes)						
fibre						
miriti/moriche	8,700	961	390	860	890	1,100
piassaba	1,900	50,290	55,190	40	300	560
bastard cedar	—	—	30	—	—	—
malva	—	—	70	—	—	—
star-nut palm	—	—	101	100	—	—
barbatimao	—	—	2,710	—	—	—
mangrove	—	—	410	—	—	—
carnaúba	—	1,557	—	—	—	—
medicinal						
jaborandi	—	—	—	—	—	1,600
locust	—	—	20	—	—	—
rotenone	—	—	30	—	—	—

Table 27b. Value of non-timber forest products, Brazil

	[1]1979	[2]1981	[3]1987
value (US$ 1,000)			
latexes			
rubber	[4]20,486.5	—	20,736.0
mangabeira	6.4	—	—
sorva	1,713.7	1,635.2	316.0
balata	257.8	229.9	11.0
chicle	1.8	—	—
massaranduba	209.2	212.6	239.0
caucho	766.5	1,496.4	42.0
waxes			
carnaúba	16,435.6	—	—
edible/drinks			
Brazil nuts	10,874.0	10,982.9	9,070.0
assai juice	[5]4,810.5	[6]593.9	42,023.0
palm heart	2,744.1	854.8	11,823.0
mangaba	86.1	1.6	—
oils/aromatics			
babassu oil	61,211.5	0.7	22,631.0
copaiba oil	21.8	99.0	123.0
tonka bean	67.4	289.9	224.0
licuri	—	17.1	185.0
urucuri	—	—	—
crabwood	11.1	1.6	—
murumuru	0.6	0.5	—
ucuúba	8.8	41.1	—
star-nut palm	2,095.2	—	—

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(continued)	[1]1979	[2]1981	[3]1987
value (US$ 1,000)			
fibre			
miriti/moriche	225.5	34.0	413.0
piassaba	13,035.0	277.2	151.0
cipó-imbé	—	12.3	—
bastard cedar	4.5	2.1	—
malva	12.7	0.7	—
star-nut palm	39.1	0.5	—
barbatimao	169.1	0.4	—
mangrove	27.8	1.8	—
medicinal			
jaborandi	—	—	905.0
locust	8 4	17.4	—
rotenone	3,0	2.8	—
total	**135,333.7**	**16,806.4**	**108,892.0**

Source: Richards (1992), except for 1979: Balick (1984), based on data IBGE; 1981: Fearnside (1989), based on data IBGE

Notes: 1. conversion rate: 1.0 US$ = 42.33 cruzeiros; 2. conversion rate: 1.0 US$ = 96.65 cruzeiros, being the average of the official exchange rates for the first and last days of 1981; 3. value to producers (exchange rate 1US$ = 41.47 cruzeiros); 4. coagulated and liquid latex together; 5. seed; 6. fruit.

Table 28. Export of non-timber forest products, Brazil: 1985

value (US$ 1,000)	
sorva latex	2,875
rosewood oil	938.1
copaiba balsam	125.0
balata latex	10.2

Source: Prance (1989)

Table 29. Export of non-timber forest products, Belize

volume	1987	1988	1989
chicle (kilograms)[1]	—	50.2	90.8
dyewood/logwood (tonnes)	78.0	—	—
izote (units)[2]	—	—	720,000.0
other ornamental plants (units)[2]	800.0	800.0	—
value (US$ 1,000 FOB)			
chicle	—	189.0	300.0
dyewood/logwood	21.0	—	—
ornamental plants[2]	2.0	2.0	—
total	**23.0**	**191.0**	**300.0**

Source: Heinman and Reining (1989).
Notes: 1. Converted from pounds: 1 lb. = 0.454 kg; 2. Estimates from the authors from interviews and field inspections.

Table 30. Export of non-timber forest products, Guatemala

	year	volume (tonnes)	value (US$ 1,000)
allspice	1986	394.0	230.0
mimbre	1986	10.5	11.0

Source: Heinzman and Reining (1988).

Table 31. Some non-timber forest products: Colombia

Non-timber forest products in Colombia (monetary value unknown)

scientific name	common name	part used	product
Aviceniagerminans	mangrove (Palo de sal)	bark	acid for vitamin B2
Banisteriopsiscaapi	yagé	bark	ritual drink
Cassiasp.	alcaparro	whole plant/ fruits	ornament/food/medicine
Coumaroumaodorata	tonga (sarrapia)	seeds	perfume/soap/aromatic
Strychnessp.	curare	n/a	poison
Rizophoramangle	mangrove	bark	tanins
Bertholletiaexcelsa	Brazil nut	seeds	food
Gliricidiasepium	matarratón	leaves	medicine
Elaeagiapastoganomophora	mopa-mopa	buds	resin, timber preservation
Borojoapatinoa	borojó	fruits	drink/aphrodisiac

Source: Delgado (1990).

Table 32. U.S. Import of xaté from Guatemala and Mexico

	1979	1980	1981	1982	1983	1984	1985	1986	1987
volume (millions of stems)									
Guatemala	163.2	123.6	76.4	73.5	26.7	31.8	51.5	38.9	71.7
Mexico	278.0	334.3	255.8	246.2	215.7	233.0	291.5	**315.1**	350.3
total	**441.2**	**457.9**	**332.2**	**319.7**	**242.4**	**264.8**	**343.0**	**354.0**	**422.0**

Source: Heinzman and Reining (1988).

Table 33. U.S. imports, non-timber forest products (average)

	value (US$ 1,000)
sorva latex	3,068.0
Brazil nut	17,679.0
rosewood oil	980.0
tonka beans	139.0
copaiba balsam	45.0

Source: Prance (1989), quoting Prescott-Allen and Prescott-Allen (1986)

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