*Proceedings of the Workshop:*

# Cultivating (in) Tropical Forests?
# The evolution and sustainability of systems of management between extractivism and plantations

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# TABLE OF CONTENTS

## INTRODUCTION

The idea of a organizing a symposium on “Intermediate systems” arose from two distinct but inter-related research projects:

- FORRESASIA - “Alternative strategies for forest resource development: extractivism, agroforestry or plantations” - a project funded by the INCO programme of the IV$^{th}$ framework programme of the European Union (IC18-CT96-0077 – DG 12 MUYS). The main focus of this project was to compare the benefits, constraints and evolutionary trajectories of existing models of forest resource management, namely extraction of plant products from the wild, production in various forms of agroforestry systems, and intensive production in specialized systems. The research was conducted in Indonesia and the Philippines between January 1997 and December 2000. It involved eight research institutions and NGOs in these two countries, in addition to France, Norway and Spain.

- An international comparative analysis of cases of NTFP commercialization, led by CIFOR. This project investigated the characteristics of products and their production, processing and trade to understand the role of NTFP commercialization in achieving conservation and livelihoods improvement. It included a total of 61 cases from 27 countries in Asia, Africa and Latin America.

The editors of these proceedings, have been exposed to a range of IS in their research careers. Working around NTFPs, shifting cultivation and native agroforestry practices throughout the tropics, we have visited “forests” where many resources had been purposefully retained, encouraged or even planted, and which often did not correspond to our western perception of plantation, orchard or garden. We all saw the obvious convergence between these different systems, representing variations of the same model of resource management, and recognized a lack of adequate terminology to define them. These forest-like systems, in which human influence and design was of major importance, we called forest-garden, agroforest, man-made forest, or by their local names. However, as examples of these systems continued to expand, we began to feel a real need to identify a unifying term, together with a supporting framework of concepts, theories, and hypotheses.

Our observations and analyses mainly evolved from our research in Southeast Asia. In our FORRESASIA/CIFOR partnership, we had long discussions about the common features these systems share, the important role they can play in resource management and socio-economic development, and the potential they have for wider application. But we also recognized the importance of relating the experience we had from Southeast Asia with observations from other parts of the world. We also felt the need to work collectively, with colleagues from throughout the tropical belt, on the development of a conceptual framework able to unite observations, scientific analyses and practical recommendations on these systems. The idea of the Symposium grew out of this need.

In an effort to circumscribe the range of systems that we wanted to address and call for the Symposium, we used the term "Intermediate systems". This term was intended to refer specifically to the *intensity* of input into the systems—lower input per unit of land than in pure plantations but greater input per unit of land than in pure extractive systems, and the *structure*—not really a natural forest, but far from homogeneous plantations. It also referred to our conviction that the current dichotomy between extraction (from "wild" or "natural" vegetation) and plantation is not relevant for the study of native forest management models in the tropics, and that there exists a large continuum of management possibilities between pure extraction and intensive monoculture plantations. This idea of "intermediate" also allowed us to question the agriculture/forestry divide by introducing a challenging paradigm.

The Symposium was designed to bring together specialists with expertise in "intermediate systems", from various disciplines and geographical areas, to explore these relevant issues and research questions, and to develop a stronger theoretical framework based on their collective experience and ideas.

We also wanted to critically examine the different positions in the debate about these native (or local) forest management systems. At one end of the spectrum are those who question the economic and/or ecological sustainability or profitability of IS, arguing that they are just stages of "primitive horticulture". At the other end are those who argue that IS are able to meet economic, ecological and social objectives better than either extractive systems or specialized, intensive systems and that such systems are more than just transitional stages, may be viable over long periods of time, and have a wide potential for development.

As a result of the above-mentioned ideas, discussions, and identified needs, a Symposium was organized to address the topic: "Cultivating (in) tropical forests? The evolution and sustainability of systems of management between extractivism and plantations."[2] Using a number of case studies presented from all over the tropics as a reference point, we asked the contributors to focus their presentations on two closely related aspects: (1) the driving forces and evolution of such systems over time, and (2) their stability and sustainability. More specifically, we wanted to address the following questions in order to be able to make some generalized answers:

1. What are the long-term development trends? Some theories of agricultural development suggest a natural evolution from hunting and gathering from natural forests to agriculture and domestication in highly artificial fields. Are intermediate systems merely an intermediate stage in the evolution from extractive systems to

[2] The Lofoten meeting was supported jointly by the EU (partly through the FORESSASIA project, the European Tropical Forest Research Network (ETFRN, http://www.etfrn.org/etfrn/ ) and the Center for International Forestry Research (CIFOR), located in Bogor, Indonesia http://www.cgiar.org/cifor/.

intensive plantation systems? Or do they represent alternative pathways for forest domestication and production?

2. Under which conditions can these systems be stable and sustained over time? Are there specific conditions (historical, markets, specific products, agricultural development, factor scarcity, etc.) under which "intermediate" silvicultural systems emerge and are maintained in traditional or modern forest management?

3. What are the key driving forces? What is the relative role of various factors:
   (a) *economic and demographic:* higher population densities (i.e., land scarcity) and relative scarcity of the basic factors of production (e.g., land and labor), market access, and demand;
   (b) *technical and ecological*: level of natural resource availability, patterns of resource dynamics, carrying capacity and available technology; competition; and sustainability;
   (c) *political:* conflicts of uses or rights over land and plant resources between communities and outsiders, customary *vs.* statutory law;
   (d) *social and cultural:* perceptions, social or cultural preferences, social strategies in forest and agricultural development, social organization of production.

4. What is the role of these systems in the overall household economy and what is their place in the overall agricultural production system? Are they primary food and cash earners, or are they primarily *insurance systems* during slack seasons, in periods of shocks and crisis, or in certain periods of the life cycle?

5. What is the role of these systems in local social strategies? Are they established only for economic purposes or do they also fulfill other functions (such as land appropriation, patrimonial strategies, or social independence)?

6. Do they act as forest substitutes or do they still complement natural forests? For local communities? At the landscape level? For biodiversity conservation?

7. What are the comparative advantages of intermediate systems (e.g., *vs.* pure extractivism or specialized plantations), particularly with respect to the economic (income and insurance) and ecological (biodiversity) aspects?

This report includes a detailed concept note that provides an overview of the issues and lessons drawn from the workshop, illustrated with detail and examples from the many cases and the abstracts of the submitted papers with boxes summarizing the main details about the case studies. A more comprehensive work, based on selected papers from the Symposium plus several invited contributions, is also in preparation.

The Symposium was held in Kræmmervika, Ballstad, a fishing village in the Lofoten islands of Northern Norway. Although no tropical intermediate systems can be found in the area, the place offered us its unique blend of an alpine landscape, fishing culture, and – of course – the midnight sun, which together with the freezing breeze of the polar circle, made for particularly stimulating discussions of tropical IS. The 37 participants attending the workshop came from all over the world—including Europe, Asia, Africa, and the Americas—which contributed to a lively exchange of highly diverse experiences and ideas on which to build the framework on intermediate systems presented in these proceedings.

# CULTIVATING (IN) TROPICAL FORESTS? THE EVOLUTION AND SUSTAINABILITY OF SYSTEMS OF MANAGEMENT BETWEEN EXTRACTIVISM AND PLANTATIONS

*By Brian Belcher, Genevieve Michon, Arild Angelsen, Manuel Ruiz-Perez and Heidi Asbjørnsen*


## ABSTRACT

Rural households throughout the tropics have developed a wide range of systems for the management of forest resources. An interesting and valuable class of systems is those that are intermediate on the continuum from pure extraction to plantation management. Such "intermediate systems" (IS) range from natural forests modified by managers for increased production of selected products through to anthropogenic forests with a high density of valuable species within a relatively diverse and complex structure. IS offer important subsistence and cash incomes, as well as attractive strategies for capital accumulation, risk spreading, and labour reduction. They can also help to secure tenure rights and yield significant biodiversity benefits at both local and global levels.

Despite these important contributions of IS to maintaining functioning of both the human and ecological systems in the tropics, IS have been largely overlooked by the development community. This is party because IS fall outside of the dominant agriculture/forestry divide paradigm, but also because of the absence of a recognized conceptual framework. This paper contributes to the development of such a framework by identifying some common features of IS, summarizing their key social, economic and environmental advantages and constraints, and examining the trends and driving forces that lead to their development, persistence and, in some cases, decline. We identify the conditions under which such systems can be important and conclude with a discussion of policy implications.

# 1 "INTERMEDIATE SYSTEMS"?

The past two decades have seen a resurgence of interest in the many products and services of forests. The age of colonial exploration was fueled, in part, by the search for new products from the tropics, many of which are now labeled "non-timber forest products" (NTFPs). Tropical forests were then valued for their non-wood resources as much as for their timber. That interest in NTFPs peaked before WWI with the development of industries based on natural products such as latex and resins. Interest then languished post WWII as ideas of industrialization and mass production dominated, not least in agriculture and forestry. Forest management became more or less exclusively a tool of the wood industries. But then, beginning in the early 1980s, in conjunction with the "sustainable development" movement, an increased recognition emerged of the actual and potential value of forests to provide many different products and services. Once again interest in NTFPs surged, but this time the focus was on using them as tools to achieve simultaneously forest conservation and poverty alleviation. The new interest in NTFPs tended to focus on the collection of products from the wild. The term "extractivism" was coined, first in Latin America, to describe this kind of forest use. It implied, sometimes correctly and sometimes not, that people simply went to the forest to take what they needed as a kind of "subsidy from nature". At the same time, as certain products attained high value, there was pressure to cultivate and manage them more intensively. This divide between extractivism and cultivation of NTFPs reflected the important dichotomy that characterizes forest management more generally, namely between *natural forest management*, which refers to the use of wild resources in natural ecosystems, and *plantation forestry,* referring to specialized and intensively managed resources.

While international interest waxed and waned and waxed again, forest people continued to manage, use and trade a wide range of products. The reality of local forest management is much more varied than the extractivism/cultivation divide suggests, with a continuum of production systems between the two extremes. Various intermediate systems (IS) have been described, both contemporary and historical, that involve management of naturally occurring forest species, enrichment planting and fostering of valuable species in natural forests, or incorporation of forest species into agricultural production systems. Models developed by small-scale (often indigenous) forest managers range from light management of a particular resource/species in a native ecosystem to the total replacement of the original forest by forest-gardens, agroforests or plantations.

IS represent a large zone on the continuum of management possibilities between pure extraction and intensive monoculture plantations. Unlike pure extraction systems where products are gathered from the wild, intermediate systems are deliberately managed for the production of (predominantly) forest products. They use lower inputs per unit of land than pure plantations. The production unit is typically a diverse ecosystem that maintains many economic as well as ecological functions, unlike specialized tree plantations. "Intermediate" therefore refers to two key and related aspects, namely the intensity of inputs and the ecosystem structure and function. It does not necessarily imply a temporal evolution, though whether or not such systems are in transition toward more intensive management is an important question explored more fully later.

In practice, many of these intermediate management models are used by smallholder farmers, outside natural forests, in complex forest gardens within predominantly agricultural landscapes. And yet, for a number of reasons, this seemingly promising and rich set of management models has been largely overlooked by development practitioners and policy makers.

There are two opposing sets of arguments concerning the potential and value of IS. Some question the economic and/or ecological sustainability or profitability of these systems, arguing that they are just stages of “primitive horticulture” in a transition from hunting/gathering to modern agriculture or silviculture (Sauer 1952, Harris 1972, Purseglove 1974, Homma 1992). This perception has resulted in a lack of official acknowledgement and inadequate technical support for these intermediate systems.

Others argue that IS are able to meet economic, ecological and social objectives better than either extractive systems or specialized intensive systems (Padoch & Peters 1993, Michon & de Foresta 1999). In particular, they provide a good compromise between biodiversity and productivity considerations (van Noordwijk *et al.* 1997). They also fit well as an integral part of the overall household economy. Proponents argue that such systems can be more than just transitional stages, and may be viable over long periods of time. If so, there is a strong rationale for investment and policy interventions to protect existing IS and to promote the expansion of the model.

The Lofoten workshop grew out of a recognition that IS developed throughout the tropics share a number of common features, can play an important role in resource management and socio-economic development, and have potential for wider application. IS may, for example, fit well with buffer zone management schemes around protected areas, or with other integrated conservation and development projects. They might also represent the “best bet” for perennial crop production in smallholder production systems, especially in areas where natural conditions limit the development of intensive cropping of annuals. Our goal is to critically examine the different positions in this debate. We focus on two closely related aspects, the driving forces and evolution of IS over time, and their stability and sustainability. These two aspects provide a unifying theme throughout this concept paper, and are also addressed by many of the abstracts that follow.

This paper will introduce IS as a concept and explore some of the key issues and questions surrounding IS. The paper begins, in section 2, with a few examples of intermediate systems to set the stage for the discussion that follows. These and several other systems were discussed and analyzed in detail during the workshop. Based on this presentation, we summarize some of the common elements of IS. In section 3 we discuss important benefits of this class of management system. The role of IS in household economies, their technical requirements, and their importance in social strategies, ecological structure and functioning, and national economies are examined. We then examine the question of “dynamics” in section 4, considering the development trends and key driving forces that influence the emergence and evolution of IS. How and why do these systems emerge, persist, and decline? Within this discussion we provide an overview of several theories and frameworks that conceptualize the development from extraction to intensive production in agriculture and forestry, with an effort to identify weaknesses/failings in the current understanding of IS. Finally, in the last section, the key question is whether, and under what conditions, these systems can be viable. We then step back and summarize the discussion, before concluding with a brief consideration of some policy and research implications.

# 2 INTERMEDIATE FOREST MANAGEMENT SYSTEMS – AN OVERVIEW AND A FEW EXAMPLES

## 2.1 THE RANGE OF OPTIONS

There are numerous contemporary examples of intermediate systems. Some of them are centuries old practices, like the *miang* tea system in Thailand and China, and the benzoin gardens and cinnamon gardens of western Indonesia. Others have been developed more recently: rubber and damar gardens at the turn of the 20$^{th}$ century; cardamom cultivation in Laos a few decades ago. They span a range of approaches from the intensified production of one or more products within a natural forest through to anthropogenic forests maintained or restored on (formerly) agricultural lands (see Michon & de Foresta 1999, and Wiersum, this volume). Here we give a brief account of some examples that were discussed in detail during the workshop.

## 2.2 MODIFIED NATURAL FORESTS

The most basic form of management beyond pure extraction is to modify the environment to favour the production of a valuable product. This might involve weeding around valued species, opening the canopy for light-demanding species, or encouraging shade plants for shade-demanding species. The fostered plants might be self-sown or they might be deliberately planted, from seeds, seedling, or wildlings moved to preferred locations. The *miang* tea production (described by Watanabe *et al.* 1990) provides a good illustration. The system is practiced from Northern Thailand to Southern China, with a range of traditional practices. The least intensive approach is to clear some of the forest vegetation around wild tea bushes to reduce competition for water, nutrients and light, and so increase their natural production. These gardens usually have a low density of tea. More intensive practices involve planting of seedlings raised in nurseries, or transplanting of wild saplings, to locations in the forest where the undergrowth has been cleared, with canopy trees retained to maintain regular shade. These gardens can be maintained for over a century, with replanting of senescent trees if needed. Tea trees are only lightly pruned, compared to commercial tea-estate practices. The system is evolving towards more open tea gardens, such that the most “intensive” tea gardens have few of the original tree species left. Practices of this kind have also been well documented in the Amazon region, with the management of cultivated stands of *Euterpe* palms—for palm heart and juice production—in swamp forests (Anderson 1987; see Box 1), or of Brazil nuts (Balée 1989; see Box 2), while in Southeast Asia, cardamom cultivation in Laos provides another example of modified natural forests (see Box 3).

**Box 1: Açaí palm in the estuary of the Amazon river (by Susan Mogenburg)**

Açaí palms (*Euterpe oleracea*) are estimated to dominate forest canopies in ca. 10,000km$^2$ of floodplain forest in the Amazon River estuary, Brazil. Acaí is the source of two economically important non-timber products: palmito or heart of palm, and fruit, which is made into a beverage that is a staple in the regional diet. The strong, international palmito market is valued at $US13 million, while the growing, regional açaí fruit market is worth approximately $US20.3 million. Açaí is a favored forest species for producers because the two products complement each other seasonally. The prevalence of açaí management in the estuary emerged in the 1960's, when markets for both products grew due to depletion of other palmito sources and growing urban fruit markets. Forests managed for açaí begin as either abandoned agricultural fields or as non-managed forests. Management involves planting and relocating açaí seeds and seedlings, weeding, thinning, and girdling other species, and maintaining optimal densities of palms. This management results in forests that appear ecologically intact, but which differ greatly from non-managed forest. Specifically, managed forests have significantly more palms and fewer stems of hardwood trees, vines, and lianas than do non-managed forests, which also have a higher, more closed canopy and greater overall stem densities and basal area. Furthermore, açaí managed forests support a significantly different bird community than do non-managed forests. Due to these ecological impacts, açaí management should be only one part of a landscape management strategy for the Amazon estuary that includes improved incomes for estuary inhabitants.

**Box 2: Brazil nut (by: Adrienne Henkemans)**

In the northern Bolivian Amazon the Brazil nut tree (*Betholletia excelsa*) performs itself as a backbone species of a complex agro-extractive forest management system. It is a tropical evergreen tree species endemic to the forests of the Amazon river basin of South America, usually growing at an abundance of only a couple of trees per hectare. It is an emergent tree that reaches a height of about 50m, forming an upper canopy component of the terra firma forest. The species naturally propagates by the production of large fruits in the form of spherical woody pods that contain 10-25 Brazil nuts and ripen and fall between November and March. Amerindian forest dwellers as well as multi-ethnic colonists collect the nuts for subsistence purposes and for income generation. They manage the trees in primary forest stands, protecting and promoting the trees in their developed agroecosystems, a practice that in some areas has resulted in clusters of 15-20 mature trees per hectare. For the Amazonian forest dwellers the Brazil nuts are an important additive to their diet, containing high amounts of digestible fats and proteins. The bulk of the nut harvest, however, is sold on national and international markets, contributing to the economic livelihood of the collectors and other entrepreneurs involved. World-wide the nuts are consumed raw, roasted or processed into sweets, oil, soap and other cosmetics. Other parts of the tree such as the bark, wood and leaves are used locally for medicine, fuel, timber, tools and handicrafts. About half of the 12,500 urban and rural Brazil nut collectors are independent forest dwellers who, on average, depend on the nuts collected from their family forest plots for more than one-third of their income. The owners of the forest plots take care not to damage the Brazil nut tree and its habitat with slash and burn activities by establishing their agricultural fields in areas without such trees. In order to increase the amount of the harvest and facilitate collection of the nuts, they remove the undergrowth of the trees as well as lianas that climb the tree. Thus, the Brazil nut tree is part of an agro-extractive system that relies on the maintenance of a primary forest cover and a large diversity of species.

**Box 3: Cardamom gardens in Southern Lao PDR (by Joost Foppes)**

Cardamom (*Amomum villosum*) is the second largest agricultural export from Lao PDR. Every year 400-500 tons of dried seeds are exported to China, where it is used in as an ingredient in Chinese medicine, known as "sha ren". Roughly 70% of cardamom produced in Lao PDR comes from the wild, 30% from cultivated gardens. Export price has been stable around US$ 7 per kg dry seed over 5 years. Cardamom cultivation is wide spread in the districts of Bachiang, Pak Xong and Laongam in Southern Laos. These gardens are not real plantations in the strict sense, as they are established in clearings in the forest where wild forest cardamom is allowed to regenerate after a year of growing upland rice. By weeding and other cultivation measures such as pruning larger trees and clearing climbers, farmers achieve an almost pure stand of cardamom. Cardamom remains the dominant ground cover for a period of 20-40 years, while the secondary forest grows back over it with time. In the village of Ban Kouangsi, 200 families have cardamom gardens. Due to the hilly terrain, it is difficult to grow paddy rice. Two thirds of these families cannot produce sufficient rice and have to buy rice to feed the family all year round. Cardamom sales make up 35% of gross crop income per family and 87% of the cash requirement to buy rice. Other major cash income sources were groundnuts and livestock sales. All cardamom gardens are owned by someone, as there is no "open access". The best cardamom is said to be from 3-4 year old fields; however most fields are 20-30 years old, while the oldest field was 60 years old. These gardens continue to produce over an indefinite period of time, as long as the gardens are maintained properly. Maintenance is done once a year, at the same time as the harvesting. Cardamom needs some shade. Harvesting of cardamom usually takes place in October. The average yield is 120 kg/ha dry seed. An average family of 5-6 persons has 1-2 ha of cardamom gardens.

## 2.3 FOREST GARDENS WITHIN THE FOREST MATRIX

More intensive systems involve greater and longer-term interaction between human production efforts and natural forest cycles. Whereas most examples are closely integrated with agricultural systems (see next section), some are purposefully integrated and maintained within forest stands. A good example of this kind of integration is the benzoin cultivation system practiced in North Sumatra, Indonesia (see descriptions by Garcia, Katz, Michon, this volume). Benzoin is a medium-sized tree that occurs naturally in the undergrowth of lowland and montane forests of South-East Asia. It produces a fragrant resin used as an ingredient in incense and perfumes. In the benzoin cultivation system developed by *Batak Toba* people in North Sumatra, benzoin trees are first planted in the undergrowth of a patch of natural montane forest. Canopy trees and undergrowth species are then selectively cut as the benzoin trees develop to maintain a micro-environment with high light and low temperature. High-quality hardwood species and pines in the canopy are favored while others are removed, leading initially to a relatively low diversity of mature trees. The undergrowth retains many shrubs and epiphytes typical of the surrounding montane forest. As long as benzoin trees are tapped for resin – beginning as early as year 10 and continuing for up to 35 years - the garden is maintained and its structure remains somewhat open. Management is gradually reduced, with less and less control over the self-established tree species, and the garden is abandoned after a maximum of 65 years. This gradual relaxation of maintenance practices allows the garden to revert to a natural forest structure. After several decades, the resulting "pristine" montane forest can be used again for benzoin production if needed. Another example of a forest garden system that may be established within the forest matrix is the collection of paper bark from particular forest tree species for handicrafts production in Mexico (see Box 4).

**Box 4: Paper bark in Mexico (by: Citlali Lopez)**

One of the most commercialized handicrafts in Mexico is hand-made bark paper, traditionally manufactured by the Otomi, an indigenous people living in central eastern Mexico. A growing number of temporal harvesters from an extended area are involved in bark extraction as bark paper demand has increased in recent years. Further, a growing number of tree species have been adopted as raw material. Six of the bark-tree species belonging to the genus *Ficus* are used since ancient times by the Otomi for ritual paper manufacturing. An additional seven tree species belonging to different genera have been adopted during the last 30 years. These trees usually occur as scattered individuals or in dense aggregations in gallery forests, forest patches, fallow lands, homegardens and shaded coffee plantations. Among them, the most intensive extraction occurs from *Trema micrantha,* a tropical pioneer tree species commonly growing in shaded coffee plantations. As part of coffee plantation management *T. micrantha* are removed after four to six years old to avoid plant competitiveness and tree shade excess. At present these trees are completely debarked by temporal harvesters. Bark paper manufacturing is largely depending on shaded coffee plantations, which at a regional level represent important niches for nature conservation due to their high biodiversity and constitute important key multiple purpose land use systems for small-scale farmers.

## 2.4 ANTHROPOGENIC FORESTS FROM AGRICULTURAL ANTECEDENTS: ROTATIONAL SYSTEMS

Most existing examples of IS are closely integrated with agricultural systems. Examples of anthropogenic forests in agricultural lands range from rotational forest cultivation systems that are integral parts of a shifting cultivation system through to permanent forest-gardens. Unlike the examples above, in these systems the original forest ecosystem is more-or-less completely removed and a new forest is generated for specific production purposes. South-East Asia has a particularly good representation of these systems.

For example, rattan is cultivated as part of traditional swidden cultivation systems in Indonesia (first described by Weinstock 1983, see also Fried 2000, and in this volume descriptions by Angelsen *et al.*, Belcher *et al.*, Garcia *et al.*, Michon), and in south-western China (Pei *et al.* 1994). The rattan is planted along with, or subsequent to, rice and other annual crops, and allowed to grow in the regenerating forest during the fallow period. Rattan canes can be harvested beginning 8 to 12 years after planting (or earlier, depending on species and local conditions). The commonly cultivated rattan species grow in clumps and harvest of individual stems does not kill the plant. The rattan garden can yield canes for the following 20 to 50 years, which is usually accompanied by a notable enrichment of garden plots with fruit trees. Rattan "gardens" resemble a naturally regenerated secondary forest except that they have a higher density of rattan (and often other valuable species as well). Productive gardens may be managed for 50 or more years, or recycled in the swidden cycle after two or three "crops"—3 to 6 years after the first harvest—for a new rice-and-rattan cycle.

Rubber gardens in the lowlands of Sumatra and Kalimantan provide another example of rotational forest production (see Laxman *et al.*, Danielsen *et al.*, this volume). Though the cultivated rubber tree is not a native species, swidden cultivators in Sumatra and Borneo adopted it into their swidden production system not long after its introduction in the colonial estates in the late 19$^{th}$ century (Pelzer 1945; Dove 1993; Gouyon *et al.* 1993). Rubber trees, sown in a rice swidden and growing in a secondary (fallow) forest can be tapped after 8 to 10 years. The normal cycle for this small-holder rubber production is of 35 to 40 years, but some rubber gardens are managed over a longer time, with gradual replacement of senescent trees by self-established rubber seedlings. After a maximum of 70-80 years yields decline significantly and the garden must be re-established.

Rubber gardens tend to be more permanent than the rattan gardens described above, and the tree density is higher. However, as with rattan gardens, their structure is similar to that of the typical successional vegetation and, even though rubber trees are exotics, rubber gardens are often confused with natural secondary forests. Due to their perennial nature, combined with management practices that leave a major role to natural processes, the rubber gardens have high biodiversity. This partially-managed richness provides many secondary products—plant-based foods, fibres, medicines and other products, timber, game meat—which compensates for the relative low productivity of the rubber. In addition to this economic importance for farmers, rubber gardens play a role in the conservation of plant and animal biodiversity in the lowlands. The importance of this role is increasing with the depletion of the last unlogged dipterocarps forest of this ecozone (Gouyon et al 1993).

## 2.5 ANTHROPOGENIC FORESTS FROM AGRICULTURAL ANTECEDENTS: PERMANENT FOREST CULTURE

Other examples of forest gardening practices in Indonesia have resulted in the establishment of domesticated forests with diversified economic functions, and with structures and species diversity approaching those of late-successional or old-growth forests. In the example of damar gardens (a resin-producing *dipterocarp*) in Sumatra (Michon *et al.* 2000), the plantation starts, as in the rattan system, with damar seedlings co-planted in the swidden field and developing with the fallow vegetation. Damar gardens are not tapped before 25 years, and there is a high level of recruitment of other species in the interim. In the mature garden, natural processes and appropriate management of individual trees helps maintain a system that produces and reproduces without disruption in structural or functional patterns. The garden becomes more diverse with the establishment of more climax forest species in the cultivated stage. After 40-50 years, the damar plantation reaches its peak production period.

From a socio-economic point of view it is not fundamentally different from a specialized commercial plantation. Damar resin provides the majority of household cash income and complements the rice-based farming system (Levang 1993, Michon *et al.* 2000). However, from a biological point of view, the mature phase resembles more the forest it replaced than a conventional tree plantation. The resulting forest is characterized by a high canopy, a dense undergrowth, high levels of biodiversity, and perennial structures.

Other examples of such permanent forest culture exist in Indonesia. In West and Central Sumatra farmers integrate the production of cinnamon with coffee or nutmeg below a high canopy of large trees cultivated for timber and fruit production (Michon *et al.* 1986; Aumeeruddy & Sansonnens 1994). The cinnamon stand is usually completely harvested after 8 to 12 years and then replanted. Some incremental harvesting can be done if needed. Self-established vegetation is usually conserved. However, due to the high density of the cinnamon stand, the main plant biodiversity is in epiphytes on the canopy trees, small lianas, and undergrowth herbs. Many types of fruit-based forest gardens are to be found throughout the Sumatra and Kalimantan lowlands (de Foresta *et al.* 1993; Salafsky 1994). Some of the better-documented systems are the highly-diverse fruit forests of East Kalimantan (Bompard, 1988; Seibert 1989, Sardjono, 1992) and the illipe-nut gardens in West Kalimantan (Momberg 1993; Padoch & Peters 1993; Sundawati 1993; de Jong 1994). In North Sulawesi and in Lombok, forest garden systems are centered around a sugar-producing palm (*Arenga pinnata*) and in the Moluccas coconut trees and tall nut-producing *Canarium* are integrated in the canopy layer with the Tahitian chestnut, nutmeg or clove, or a mixture of these, plus banana groves, in the lower levels (Michon & de Foresta 1999).

Outside Indonesia, coffee, cocoa, and many other commodities are sometimes integrated with other trees. Native oil palm groves in Congo (Michon 1987), mixed fruit tree gardens in southern Nigeria (Okigbo 1983) or cocoa growing in Cameroon, which has emerged as a mixed system (see Dounias, this volume), are good examples of African IS. It has been noted that even some intensive cocoa plantations in Cameroon are shifting away from monoculture toward a more mixed system (Ousseynou Ndoye, pers. com.).

## 2.6 COMMON ELEMENTS OF INTERMEDIATE SYSTEMS

Each of these systems has it's own particular features. They have been developed under different historical, economic, social and political contexts. The driving forces and the dynamics of their emergence, expansion or decline are also varied. However, beyond, the local particularities, they exhibit interesting universal features and qualities that, collectively, are distinct from either extractive systems or true plantation systems. Intermediate systems tend to exhibit the following characteristics: [1]

*Commercially valuable main crop:* all examples of IS are designed to produce at least one commercially valuable product, and this has been a major driver behind their evolution. In many cases this product represents the main or only source of cash income to producers.
Diversification of income sources: in almost all cases, people who manage forest products in IS also manage several other crops and economic activities. Typically they are smallholder farmers, with either permanent or shifting cultivation systems that incorporate one or several field crops. Also the forest garden may contain other valuable plants, fungi, and animals that are used for subsistence and sometimes for sale. If there are natural forests nearby, they may also harvest from them. One of the repeated messages of the workshop was that it is imperative to think of these as integrated systems and not as single-product production units in isolation.

*Integration in farming systems:* related to the previous characteristic, IS usually do not exist in isolation, but are part of local farming systems, in which they complement subsistence cropping of staples and other economic activities.

*Risk spreading:* managers of IS tend to be limited in their ability to accumulate capital and are therefore vulnerable to risk. The diversification of income sources and products produced in IS helps them to spread the risk.

[1] We recognize that some of these features are not unique to IS but apply generally to much of the tropical rural economy. Yet, they are important when distinguishing IS from particularly intensive monoculture and to some extent also extractivism.

*Maximization of returns to labour:* IS tend to be found in areas where labour is the limiting factor of production, while land is usually relatively abundant (though not necessarily of high quality). People make decisions based on how best to allocate their labour time, especially during peak periods.

*Main crop has medium-term maturity and regular harvesting:* typically, IS feature products that have a short- to medium-term time frame to harvesting maturity. Examples include cardamom and coffee (4 years), cocoa (5 years), rattan, benzoin, rubber or cinnamon (8 – 10 years). The single exception in our examples is damar, with 25 years to the first harvest. Most products can also be harvested recurrently, sometimes with multiple harvests through the year (rubber, tea leaves, damar, benzoin), annually (cocoa, coffee, cardamom, fruits), or at most every two to three years (rattan).

*Diverse structure and multi-functionality:* the land cover in intermediate systems tends to resemble natural secondary forest, with a relatively diverse structure. They perform many forest functions, both in terms of supply of forest products and ecological functions.

*Clearly defined access and control systems:* Property regimes associated to IS are usually defined by customary rules, even if these are rarely acknowledged in the national legal systems. Managers have rights of ownership and often sanctions exist to protect against theft. Indeed, in some cases, the product itself (e.g. rattan in Kalimantan) serves as a *property marker*.

*A particular role in the shaping of social relations:* the social –and often the socio-political- meaning of IS is an important part of their success. These include aspects related to social stratification and local power, gender balance, or relation with dominant political and economic structures. IS are also presented by their managers as an important aspect of their culture and identity.

These characteristics help to explain the particular roles and functions of these systems, discussed next, and point to key issues to help understand how and under what circumstances these systems have developed, where they are likely to be most stable and where they are no longer be the most appropriate management systems.

# 3 INTERMEDIATE SYSTEMS – RATIONALES, ROLE AND POTENTIAL

Although there has been research and recognition of individual IS, they have rarely been defined as such (see Michon & de Foresta 1999 for a conceptual approach to the study of agroforests). Due to the lack of a practical conceptual framework to facilitate analysis, understanding and comparison among these systems, these individual approaches have been largely overlooked by the scientific community, and even more by professional foresters and rural development specialists.

There are also other reasons for this lack of professional and scientific recognition of IS. Deeply rooted prejudices exist within the dominant theories of agricultural development. The rise of agriculture, with plant domestication and ecosystem simplification and specialization for crop production, is seen as one of the most significant steps towards the development of modern civilizations. Hunting and gathering and indigenous horticultural systems in the tropics are commonly considered to be primitive forms of resource management. These perceptions of what forest and agriculture are and should be have driven the imposition of western scientific principles over local resource management approaches in the tropics.

Specialized agricultural systems were mirrored in the tree plantation model that has been transferred to the tropics for timber and pulp production, and peasant models of integrated agriculture and forest utilization have been regarded, implicitly or explicitly, as inferior to modern approaches. Traditional IS have not only been disrespected, but more often they have not been recognized at all. It is easy for agronomists and foresters trained in western agriculture and forestry schools to be oblivious to native systems that appear wild and disordered compared to the neat rows of even-aged trees in a plantation. A perfect example is found in Indonesia, where the government classified rattan gardens as “degraded forests” and systematically scheduled such lands for conversion to large-scale plantations.

As a result of these factors IS have received little attention or support. The upside is that there is untapped potential. As the multiple values of forests are increasingly recognized – for goods and services beyond industrial timber and pulp – existing intermediate systems offer a model for multiple-use forest management. Before assessing the evolution and sustainability of such systems, we need to know more about these systems and place them in a wider context. The following discussion focuses on the apparent benefits of these systems, from their role in the household economy and in social strategies to their importance in national economies and for ecology/biodiversity conservation, comparing the advantages and constraints of these systems with extractive systems and specialized plantations.

## 3.1 ROLE IN HOUSEHOLD ECONOMY

Forest products produced in intermediate systems are typically only one of several components of the household economic portfolio. These systems are usually found associated with either permanent food production systems, shifting cultivation practices, or specialized plantation practices, and are often combined with off-farm activities. They usually are important in household cash income earning – as noted above, IS typically have at least one cash crop as the dominant product, and this may be the main or only source of cash income. For example, rubber contributes about 60% of the total income of the households in a system in Riau, Indonesia (Angelsen *et al.* this volume). In the benzoin case reported by Garcia *et al.*

(this volume), income from benzoin amounts to 14% of the total income for the whole sample, and 30% for those harvesting benzoin (Angelsen *et al.* this volume).

In addition to the main commercial product, these forest gardens also contain other resources that can be harvested for either regular domestic purposes (food, fodder, fiber) or for special needs (medicinal products, ritual products or urgent cash sales). The diversity of income forms and rhythms is essential in areas where capital accumulation is difficult, where habits of saving are not well developed and where credit is expensive or unavailable; that is to say, in rural areas throughout the developing world.

Forest gardens incorporate numerous other economic functions that help diversify the farmer’s income and reinforce economic stability, effectively spreading risk. Intermediate systems also allow people to retain “option values” - they can keep a range of economic choices open for the future, a critical consideration in the rapidly changing socio-economic environments in which many forest-based people now find themselves. Diversified IS also contain other potential resources, offering the possibility of switching from existing commodities to more profitable ones if and when the market changes. Alternatively, new economic tree crops could be integrated in such systems without disrupting the overall structure of the production system. IS can also generate valuable inputs - material, fertilizers, genetic resources, capital - for other components of the overall system (see Box 5).

**Box 5. Intermediate Systems of Tree-Crop Integration in the Hills of Nepal (by: Ramji Neupane)**

In the Nepalese hills, forest and crop biomass flow into cropland in the form of organic manure, mulch, animal feed and bedding materials for livestock, accounting for a considerable proportion of nutrient supply to crops. Population growth combined with land fragmentation, large livestock herd size, deforestation and heavy extraction of natural resources have put enormous pressure on farmland and are causing hardships to farming communities. In particular, erosion rates of 8-12 tons $ha^{-1}$ $year^{-1}$ from hills threaten the sustainability of farm production. Perennial trees act as surface mulch that replenishes nutrients, conserve soil moisture and improve soil OM content. Nepal Agroforestry Foundation (NAF), a NGO, initiated an agroforestry project in Dhading district, Nepal in 1993/94 to promote the integration of perennial trees (e.g., *Leucaena leucocephala* and *L. diversifolia*, *Calliandra calothyrsus*, *Flemingia congesta*, *Morus alba* and *Gauxuma ulmiformis)* within agricultural fields. Results indicate that the project households had planted higher number of species than non-project households. Though project plots contained relatively higher amount of OM and N than non-project plots, the differences were not significant due to slow effect of trees on soil fertility and massive nutrient removal through intensive fodder, fuelwood and poles extraction. The benefit cost ratio of improved system (2.5) was higher than conventional system (1.8), and increased further to 2.9 when multipurpose species (mulberry) was introduced and used for sericulture. Multiple factors, including farm size, land ownership, livestock number, education, membership in local institutions, perception and extension, were shown to influence farmers’ decisions to adopt new practices. In particular, livestock population and male membership in a local NGO showed consistent positive and significant effects on adoption by both project and non-project households. These results suggest that integration of trees on farmland represents an intermediate level of evolution towards intensification and loose integration into the commercial strategies of small farmers in the hills. Positive perceptions, access to technology and markets, improved education and better support services would help to increase the adoption of intermediate systems.

Intermediate systems also offer opportunities for capital accumulation, something normally very difficult for smallholder farmers or shifting cultivators. Despite relatively high labour productivity, smallholder agriculture and shifting cultivation systems do not generate significant surpluses. Forest products produced in intermediate systems generate additional income (cash and direct-consumption) at low cost. Enriching the forest or planting trees in the swidden can be done with low labour inputs and provide surpluses that can be saved or converted into “luxury” consumption (often children’s education). It also creates assets that will increase the production capacity of the farm and that can be transferred to the next generation.

## 3.2 TECHNICAL QUALITIES

IS are characterized by intermediate levels of energy, capital or labor inputs, and the use of simple and relatively low-cost indigenous technologies. The technical simplicity is complemented by the full utilization of natural biological and ecological processes that are vital for both commodity production and reproduction, which implies a strong environmental knowledge base, especially of forest dynamics (Aumeeruddy 1994, Momberg 1993). Fertility is maintained over years by natural nutrient cycling processes, necessary inputs are generated by the system itself, and regeneration relies on natural processes. Thus, intermediate systems both conserve and utilize forest resources and structures (Michon et de Foresta 1999).

The simplicity and the relatively low costs of the techniques involved contrast sharply with conventional plantation forestry (or perennial crop plantations) which depends heavily on specialized technical knowledge, on high-yielding (and often genetically homogenous) planting material, and on capital and energy intensive processes of crop establishment and maintenance. Tree growing within IS, on the other hand, has multiple products and shorter investment periods and is more affordable by local farmers communities (de Foresta and Michon, 1993)[2].

## 3.3 ROLE IN LOCAL SOCIO-POLITICAL STRATEGIES

In many societies, planting of perennial species is commonly acknowledged by customary rule as conferring long-term use rights or ownership to individuals. In some places these rights are inheritable. Tree planting can be used as a strategy to establish or re-establish property rights over land. For example, the spectacular expansion of rubber, benzoin or damar plantation in Indonesian swiddens was partly driven by the need to establish stronger rights to forest lands (Dove 1994, Michon *et al.* 2000; see also papers in this volume by Dounias on cocoa planting under tree cover in Cameroon; by Michon, section on damar expansion; by Katz and Michon, on benzoin plantation, and by Aubertin on cardamom in Laos; see Box 6).

[2] Individual nurseries, in planting and transplanting tree seedlings on swidden fields, in managing intercropping phases, and in carrying-out selective clearing to sustain the growth of the commercial plants. The management of mature phases mainly involves relevant selection skills when managing the undergrowth, and above all enough anticipation to allow efficient and timely regeneration of the productive structures (Michon and de Foresta (1995)).

**Box 6. NTFPs and the cycle of rice in Laos (by Catherine Aubertin)**

Characteristically, key NTFPs in Laos are dependent on certain horticultural practices in the environment from which they are generated: the collection of such forest products is intimately connected with swidden cultivation and the cycle of upland paddy, culminating at some point during the dry season when either a rice gap must be bridged (between the previous harvest already consumed and the forthcoming harvest not yet in), or because only then is the time available for artisanal crafts and domestic maintenance (e.g., repairing thatched roofs and bamboo fences). Within this wide range of activities, some outputs may well be alternative subsistence foodstuffs, and/or marketable commodities to be sold or exchanged for rice. Broadly, these plants fall within two groups: the first, such as paper mulberry or benzoins, are those plants that grow spontaneously, with some assistance, in fields under slash-and-burn practices; while the second comprise species intentionally planted alongside upland rice to enrich the long fallow, enabling fallow fields to provide an economic yield throughout the entire period of soil regeneration, the best example being medicinal cardamom. In the rice fields, weeds and crop predators (e.g., rats and crabs) are themselves frequently eaten. Other edibles or marketables are collected along the paths connecting houses and fields, from the fallow fields, and from around the villages. The ecology and economics of such products cannot be separated from the farmers' agroecological systems and from forest production in general.

However, land is not the only target in this appropriation strategy. As in other domestication processes, ownership and control of the resource itself can be the main objective. When colonial or national policies, or even market organization, clearly favour external actors over local collectors of commercial forest resources, planting these resources in well-defined production systems can help maintain or re-establish control. Indeed, many examples of IS development in Indonesia were developed in response to a politically induced dispossession of native collectors (see for example Dove, 1994, on the transition from wild to *hevea* rubber in Indonesia). The pressure to plant might also come from a sudden increase in pressure on wild resources, which entails a quick deregulation of local control systems (see Michon *et al.* 2000 for the example of damar cultivation). It can also help capture more efficiently the benefits of their management[3] as in the case of rubber or dammar (Michon *et al.* 2000) or bamboo (Box 7).

[3] Among these benefits, local plantation often boosts local enterprises for harvesting, sorting, or semi-processing of the planted forest product, directly creating some additional value for local communities

**Box 7: Selling bamboo shoots in Oudomxay: a successful case of participatory group building (by Joost Foppes)**

In the village of Nam Pheng, Oudomxay, villagers used to be very poor, and could not produce enough rice to feed the community all year round. In the dry season they collected off-season bamboo shoots for sale, but the income was never enough. The IUCN/NTFP project assisted the villagers to analyze their problems (Soydara, 1999). In a series of meetings, the community gradually realized that they could improve their sales if they would all team up and sell for a fixed price, in a fixed place, not measured per bundle but measured per kilo. The community continued to discuss this idea until every family agreed to join the village selling group. The results exceeded all expectations. In five months, the village sold more 47 tons of shoots and earned 50 million kip or US$6,670 (on average 1 million or US$130 per family), at least four times more than the year before. The community also gained 5 million kip in a village development fund, setting aside 100 kip for every kilo sold. In the year 2000, the marketing group sold 44 tons, resulting in the equivalent of US$7,000 (1 US$ is about 7,500 kip). As a result, the community became very interested in monitoring and managing its bamboo forests. Together with district forestry officers, they are now conducting inventories of their bamboo forests and are testing various cutting regimes to determine optimal harvesting regimes.

The establishment of systems of forest plantation often creates new types of assets in traditional production systems. This might be an important incentive to plant trees or other forest plants in social contexts where land is the basis of family patrimony. In societies where production systems include both permanent and temporary elements (for example, irrigated rice fields, fruit tree gardens and swidden agriculture), there is often a clear social segregation between landlords (those who own the land developed for permanent agriculture) and the commoners (swiddeners who have no land of their own, and often no permanent housing in the village). Claiming the forest offers a way to acquire land rights on former swiddens, and this can change the social structure of the group, with swidden farmers joining the previously restricted category of landowners (Michon *et al.* 2000).

As the world looks for solutions to severe problems of poverty and environmental destruction, IS offer a way to combine the protection of forest functions and the expansion of economic opportunities through commercial tree crops. Under the current dominant model, governments in many tropical countries support large scale plantation of genetically improved varieties (of both forest and agriculture species). Commercial tree farming is usually done under the control of private or state corporations that physically and legally replace local farmers. There are many reasons for this preference, ranging from the ideological prejudices favouring "modern" production systems through to the obvious benefits of easier collection of revenues from producers who are fewer in number and who work at a larger scale. But this type of development clearly disadvantages local people who depend on forest resources, and leads to continued biodiversity loss. IS represent alternative strategies that, with appropriate research and development support, could reverse the process, and provide opportunities for rural people within a context of modernization and development.

## 3.4 ECOLOGICAL ROLE

Intermediate systems allow for the intensification of forest production while maintaining relatively high forest quality (biodiversity) and important forest functions like protecting against soil erosion, watershed management and carbon sequestration. Management increases production of particular species while restoring some of the original forest vegetation and providing habitat for forest fauna. Even in cyclic systems, where mass regeneration is used to rejuvenate the system, integrated management practices that respect natural processes in vegetation regeneration result in a relatively high level of recovery of the original forest biodiversity.

The resulting forest qualities and functions may be lower than in undisturbed ecosystems, but they are superior to current models of plantation forestry. [4] Although the main objective of IS is not to restore a forest, they nevertheless perform many restorative and regenerative functions. While forest cover is shrinking all over the tropical world, IS development could be a valuable complement to active forest conservation measures. Moreover, besides providing an original model for multipurpose forest development, they can help in reducing the ecological costs of natural forest conversion for intensive production.

IS represent good examples of the kind of small-scale, labor and energy efficient biologically-based systems championed by the "permaculture" school and others working on agricultural designs that stress ecological connections and closed energy and material loops (Diver 2001).

**Biodiversity – productivity tradeoffs**

There is often a trade-off between biodiversity (by some measure, often just a species count) and productivity (either total value of production per hectare, or profit per hectare) in resource management. A key proposition in the debate is that IS offer a compromise approach, with relatively high scores on both axes, and that the relationship is convex, as illustrated in Figure1.[5]

[4] In terms of forest ecological functions, specialised forest plantations can promote carbon sequestration or conservative water management. However, their role for soil conservation can be questioned and they do not participate much in biodiversity conservation.

[5] The curve might even have an increasing segment on the left side, as some disturbance (management) creates a more heterogeneous habitat that increases species diversity (e.g., gaps which invites colonising species).

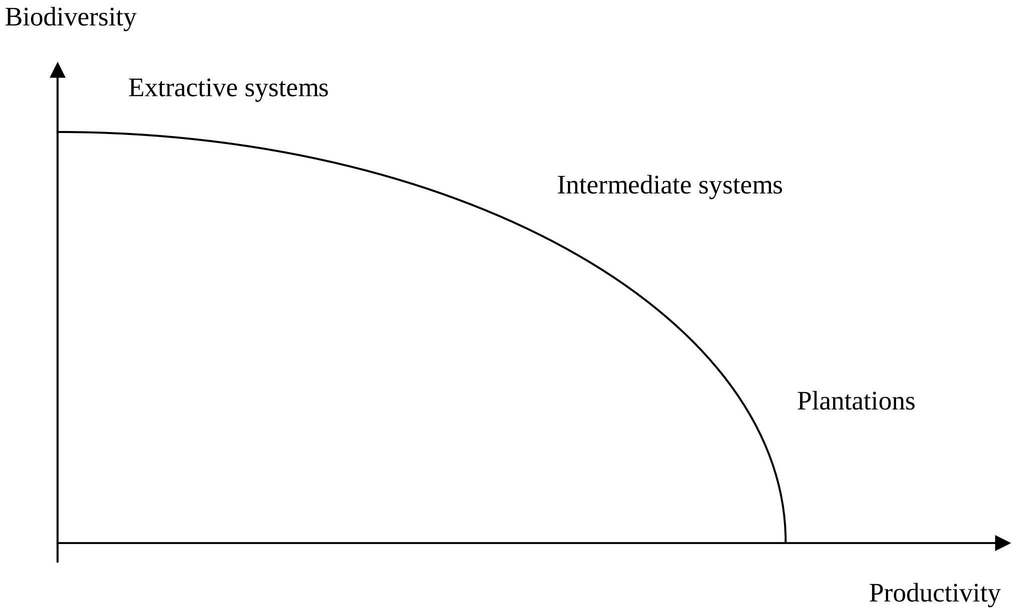


*Figure 1: Hypothesized trade off between biodiversity and productivity.*

There have been few systematic empirical investigations into this relationship, although van Noordwijk *et al.* (1997) corroborate the trends presented in the figure (see also García Fernández *et al.* 2002).

The role of IS as forest substitutes might be significant from an ecological point of view, especially in areas with high deforestation rates. In the eastern lowlands of Sumatra, where large tracts of *dipterocarp* forest have been converted to either forest plantations or non-forest use, the extensive area covered by native rubber gardens represents the largest local reservoir of plant and animal diversity (de Foresta 1993). In Southern Sumatra, damar agroforests surrounding the Bukit Barisan Selatan National Park constitute an effective extension of the natural forest and contributes to the conservation of wild mammals that need large territories, like rhinoceros, tapir, tiger and elephant (Michon *et al.* 2000). In southern Mexico, home gardens maintained by indigenous Mayan populations have served an important function in maintaining biodiversity (Box 8).

**Box 8. The Mayan home gardens of Yucatan (by: Juan Malo)**

The traditional home garden is one of the key elements for the self-sufficiency economy conducted by the Mayan peasants in the Yucatan Peninsula, and it determines the forested appereance of the villages in the region. They are land plots between 500-3,000 $m^2$ in which all the domestic facilities (e.g., hut, kitchen, latrine) are located, the domestic animals are grown, and where a variety of trees producing fruit, building materials or other goods are cultivated and/or tolerated. The tree cover of home gardens gets established through a combination of keeping species previously existent in the wild vegetation, tree planting, and by the establishment from seeds dispersed from the surroundings. All this, together with the watering and management of vegetation, leads to the high species diversity of home gardens, and to their appearance of medium or tall rainforest in sharp contrast with the vegetation surrounding the villages. Among the tree species found in the home gardens, there is a noticeable number of species from tall-evergreen and medium rainforests typical from the most humid areas in Yucatan, as well as a high diversity of non-commercial cultivars. The Mayan villages thus have a relatively high natural value from the agronomic as well as from the naturalistic point of view, since they act as refugees for cultivars almost disappeared and for species now scarce in the wild. At present, the home gardens are maintained in most villages in Yucatan devoted to the provision of goods for the Mayan families, with a minimum tendency towards the specialization of production for commercialization or to the abandonment as a result of changes in the economic activity of peasants.

## 3.5 ROLE AT NATIONAL LEVEL: CONTRIBUTION TO NATIONAL DEVELOPMENT

Many intermediate systems make significant contributions at the national level, especially in terms of foreign exchange earnings. This contribution is often concealed in national statistics as part of larger categories such as “tree products”, or “NTFPs” that may include production from industrial estates, horticultural crops or extractivism. For example, 60% to 70% of the rubber latex exported from Indonesia is produced by smallholders in “jungle rubber” gardens (see Joshi, this volume). A significant proportion of the spice crops (clove, nutmeg, cinnamon) in Indonesia also derive from such systems. In Cameroon, a large part of the exported cocoa is produced in agroforests, not in pure plantations (see Dounias, this volume; see Box 9). In Indonesia, most of the fruits entering inter-island trade and sold on local markets, are produced in various types of fruit agroforests, forest-gardens or highly diverse home-gardens. In Indonesia again, many of the most important NTFP are produced in intermediate systems, not in natural forests. This includes 100% of the dipterocarp damar resin of the clear type (8000 to 12000 tons per year, Michon *et al.* 2000)), all the benzoin exported from Sumatra, and a large proportion of small-diameter rattans.

**Box 9. Cocoa plantations of southern Cameroon (by: Edmond Dounias)**

Cocoa plantations of southern Cameroon are very old and their yield is low. Most of the plantations were created during the 1920's and 1930's. They are permanently rejuvenated by planting juveniles to replace old and unproductive plants or in gaps caused by dead trees. Average size of plantations is around two hectares and the basic production unit is the household. Cocoa plantations are generally established in mature swidden fields. Seedlings are transplanted into swidden parcels and grow among the post-agricultural regrowth. Cocoa trees have always been and still are associated with dominant trees that have diverse origins. Some are remnants of the pristine forest and were maintained during the creation of the swidden, some are light-demanding species that established during the fallow period, and some others were voluntarily transplanted or even introduced into the parcel. Most of these trees – a mixture of native and exotic species - provide NTFPs. The original shading function of the dominant trees is no longer justified, now that improved cocoa cultivars are "selfshading". Agricultural policies that aim at encouraging the intensification of cocoa production push for a systematic elimination of shade trees, because excessive shade encourages fungal attacks that drastically affect production of improved cultivars. Farmers are reluctant to eliminate these trees and prefer to maintain older cocoa varieties which are more resistant to fungal pathogens. Farmers express their preference for an optimized intermediate system (justified by socio-economic choices and land tenure strategies) rather than a maximized yield of a monospecific and cash-crop plantation.

# 4 LONG-TERM DEVELOPMENT TRENDS AND THE KEY DRIVING FORCES IN THE EMERGENCE AND EVOLUTION OF IS:

The discussion about benefits raises some important questions. If these systems are so beneficial, why are they not more common or widespread? Are they in fact competitive with other systems? Are they sustainable (economically, ecologically, socially) or are they actually gradually disappearing? Most theories of agricultural development hold that there is a systematic evolution from hunting and gathering in natural forest to agriculture and domestication in intensively managed systems, with IS representing a transitional phase. Is this correct? Or do these systems represent robust and stable alternatives to more intensive management systems? What conditions govern their sustainability or their transition to other management approaches?

We explore these questions in several parts. We distinguish between three processes related to IS development: evolution (emergence), intensification, and breakdown. We should stress that the sequencing of these three processes does not necessarily imply a linear process from one to the other. Different disciplines and schools of thought necessarily focus on different aspects and drivers of these processes. We highlight technical, ecological, economic and socio-political drivers. The key driving forces for the three processes are summarized in Table 1. There are strong similarities among the drivers of all three processes; increased land scarcity, for example, is a key driver for all of them.

| Drivers | Evolution | Intensification | Breakdown |
|---|---|---|---|
| | | | |
| Land scarcity (pop. density) | *** | *** | *** |
| Market access – price | * | *** | * |
| Labour costs | ** | ** | *** |
| Infrastructure | ** | *** | ** |
| Tenure – resource control | *** | ** | ** |
| Political recognition of IS | * | * | *** |
| Synthetic substitutes | | | *** |
| Suitability for mono-cultivation | | | *** |
| Access to appropriate technologies | | * | *** |

*** indicate level of importance of the particular variable.

*Table 1. Key drivers in the evolution, intensification and breakdown of intermediate systems.*

## 4.1 HOW AND WHY DO IS EMERGE?

Intermediate systems are organized to produce one or more traded commodities. Any discussion of the development and evolution of IS needs to consider economic factors such as market demand, the economic organization of commercial exchanges, the availability and productivity of production factors (land, labour, capital in the form of cash or credit), the household's socio-economic strategies (e.g., management of risk and wealth accumulation), and the compatibility of the system with other activities. Factors related to the social organization of the production (in particular those related to land tenure and power relations) and the political background of this production should be integrated as well. All these variables combine in various ways to influence the evolution of a system.

Homma (1992) developed a simple supply and demand model of the development of cultivated production of NTFP (Figure 2). The model begins with a system in which a product has some trade value and is available wild in the forest. During the first phase production expands as collectors harvest increasing quantities from available natural supplies to meet market demand. This continues until an equilibrium is reached between supply and demand. During this phase, which Homma called the stabilisation phase, some farmers begin to experiment with management and cultivation of the product, and a proportion of the supply is met from cultivated sources. If demand exceeds the sustainable supply from the wild resource, overexploitation will result, wild supplies will decline and - as long as demand remains high - prices can be expected to rise. This creates an incentive for expanded cultivated production, and cultivated supplies soon take over the market.

The model assumes that the development of markets (including demand for the product, a reasonable price relative to the costs of production, and organization and infrastructure requirements for the exchange) creates the stimulus for people to begin to manage/cultivate the product. Indeed, each of the examples referred to in this volume developed in response to a market for a given forest product. Aubertin (this volume) offers an example of a newly developed IS, for Cardamom production in Laos. Here, sustained demand and declining wild resources led people to begin cultivating the plant. In each case the cultivation system represents an evolutionary and not a revolutionary step. Farmers were able to incorporate a familiar product, at relatively low cost and low risk, into their existing farming system.

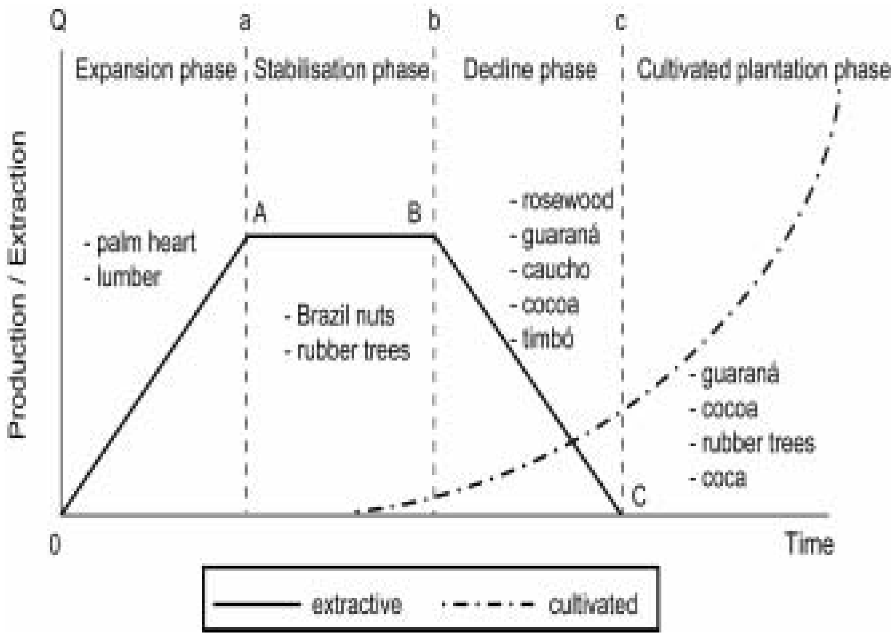


*Figure 2. Homma's model of phases of forest product extraction and cultivation.*

There are other conditions that are not explicit in Homma's model that facilitate or encourage the development of an IS. The earlier discussion has highlighted several. Property rights are important in the establishment, maintenance or collapse of IS. In the example of damar cultivation, the large-scale adoption of damar as a promising crop was stimulated by a switch in customary systems from collective land property on forest lands to the acknowledgement of land rights to the individual planter and his heirs (see Michon this volume). In most examples cited in the workshop, one of the minimum conditions required for the success of the IS is some level of tenure security.

However, IS management can also be a tool in establishing and maintaining tenure control. In many traditional tenure systems, tree planting is recognized as a mark of “ownership”, and states also sometimes recognize claims based on planted perennial crops. Whereas an abandoned fallow field may be subject to appropriation by another party, a rattan or benzoin garden, for example, is understood to belong to the person who planted it or to his family. The establishment of such a garden is a relatively low-cost mechanism of securing land tenure, and can be used as a strategy for land appropriation. Planting may be triggered by an actual or perceived change in tenure status. In situations where traditional forms of local control and ownership are questioned by external actors, or are being re-evaluated locally, local people may adopt intermediate management systems as a way to establish and demonstrate ownership. As an example, the expansion of benzoin gardens in the highland forest of North Sumatra, at a time where market prospects for the product were not bright, represents a local strategy of re-appropriation of customary lands, formerly seized by colonial forestry services for conservation purposes, in the post-independence context (see Michon, this volume). Likewise, many rubber trees throughout Indonesia have been integrated in fallow lands not just for production purposes, but also to support claims for compensation in case of forced dispossession. These attempts are made notwithstanding that in past land disputes between local farmers and private plantation firms in Indonesia, IS have rarely been recognized as a proof of land ownership deserving compensation.

## 4.2 INTENSIFICATION OF IS

Once established, IS can be maintained over the long term, abandoned, or intensified. The Homma model suggest that there is an evolutionary path, driven by economic forces, that leads from low to high levels of management intensity. In this model, IS would be intermediate along a development path toward intensive management.

This proposition is congruent with the Boserup (1965) theory that higher population densities (often equated with increased land scarcity) lead to more intensive use of the scarce resource, namely land. It implies that intermediate management systems will not be the best use of land as development proceeds and that IS will be replaced by more intensive management (higher levels of labour and capital inputs per unit of land) and higher land productivity. If this is true, farmers/land managers will abandon IS in favour of more intensive systems producing high-value commodities as land becomes relatively more valuable.

Increased market access and higher demand from outside encourages more intensive production of higher value products. As people become more integrated in the cash economy they tend to focus on producing commodities that have the highest cash value. Within a subsistence economy, people produce and use a number of goods (forest and agricultural products) that can be replaced or made less useful (or less desirable) by new products and pressures (such as advertising) from outside. Producers shift their effort from these products and intensify their production of more valuable goods.

This type of intensification does not necessarily imply the abandonment of all the products and functions of the system in favour of a single product. Intensification may occur through the diversification of production, which raises the overall profitability of the system without substantially changing its structure. For example, in the 1980s, the fruit gardens in West Java have "specialized" in a highly diversified fruit production for urban markets, using improved fruit varieties and some adjustment in the garden structure, while maintaining a mixed-species forest-like strucutre (Michon & Mary, 1990). Similarly, the damar agroforests have gradually integrated intensive production of two varieties of highly valued fruits without fundamentally changing their structure or overall management (Michon *et al.* 2000).

However, economies of scale in trade and marketing encourage specialization and intensification and expansion of production of the most rewarding products (Belcher, Ruiz-Perez and Achdiawan, 2003). This has happened in Thailand when traditional fruit gardens gave place to intensive fruit cropping for urban and international markets.

The appropriateness of any management system is influenced by a set of ecological and technical factors, including the level of natural resource availability, patterns of resource dynamics, productivity limits, competition, and the technology available. IS have, by definition, relatively low input requirements. Most such systems have developed as part of traditional systems, and are well adapted to low natural fertility/productivity. However, as people obtain access to modern technologies, including fertilizers, mechanical clearing devices (e.g. chainsaws), mechanical harvesting equipment, and improved transportation, they are better positioned to adopt a more intensive, higher-throughput model.

More intensive use of the land, which requires a higher level of investment (of labour and/or capital) may be undesirable if there is a risk of losing the land or the products of the investment. Land tenure is important here, as it was in considering how IS develop in the first place. Whereas the development of IS needs a minimum level of tenure security, increased tenure security over land, coupled with higher land values, is likely to drive intensified land-use. Secure land tenure favours more intensive management systems. At the same time, tenure security is not something fixed but is influenced by decisions taken by the land manager. Intensification is often a way to increase the claim of the land and the recognition by both local and outside land users as well as the state. Thus there is a two way relationship between the tenure security and intensification. Insecure tenure can, in fact, promote intensification if that leads to more enforceable claims over the resources (Otsuka and Place 2001).

Global forest regulations and agricultural policies are also major drivers towards intensification of IS (as they are towards their abandonment). There are many examples of direct correlation between agricultural or forest policies and intensification: in smallholder rubber production in Indonesia, national policies which actively supported (through credit facilities) the use of using cloned plant material and fertilizers led smallholder rubber growers to turn from "jungle rubber" to intensive and specialized rubber production. More often, however, the way policies affect intensification is more indirect. This can happen through extension programmes, where extension agents criticize, or ignore, traditional forms of tree management. In West Sumatra for example, extension agents provided insecticides for nutmeg production if and only if nutmeg trees were grown in well-ordered orchards, not in the native diversified fruit gardens (Michon *et al.* 1986). This can also happen when forest conversion policies consistently refuse to acknowledge local systems of forest management and the related customary systems of resource control. Many rattan gardens in East Kalimantan have been affected by conversion policies which transferred large tracts of "degraded forest" – including well-established and productive rattan gardens - to oil palm or fast-growing tree plantation companies.

## 4.3 ABANDONMENT OF IS

We also need to consider the conditions that lead to abandoning IS (as opposed to intensifying). Some are just the inverse of the conditions that lead to establishment and intensification. For example, if demand (value) of the main commercial product produced by a given IS decreases, farmers might abandon the system if there are viable alternatives (as happened in the rattan case, Belcher *et al.* this volume).

In many of the existing IS there are only one or few marketable outputs. Increased involvement in the cash economy increases the value of labour. When people have an opportunity to sell their labour they will be less inclined to engage in low value pursuits, or in activities that do not occupy them fully. While IS have relatively high returns to labour compared to other opportunities in a traditional context, it is quite possible that they will be out-competed by new opportunities arising in a cash economy context.

A contrary hypothesis is that, because IS production is less labour demanding, and often the timing of labour requirements is less critical than for agricultural activities, it may be possible to blend IS activities with wage-labour activities, filling in seasonal periods with low conventional agriculture (or off-farm) labour demand. For example, in the villages surrounding the city of Bogor in West Java, most former rice farmers have engaged in part-time urban business, but they have kept their fruit gardens as a complement of their main economic urban activity (Michon & Mary 1990).

Another economic issue that is important in determining the role of IS is risk and strategies for risk management. Households managing such systems typically produce several or many products from agricultural fields, from forest collecting, and from the forest garden itself. This strategy ensures a flow of benefits over the year and provides insurance against the risk of failure of a product or a drastic price decline. But the importance of traditional social security or insurance systems - in the form of a reserve of forest products, or social norms for sharing - tends to decline as modern insurance systems (e.g. bank savings, secure employment, and commercial insurance) develop. Thus, communities at some "intermediate" stages in this social development process might lack both the traditional and modern insurance systems and will be particularly vulnerable to shocks and crisis. If this is true, and if IS are transitional, we might conclude that IS are particularly important (or well suited) for societies at some "intermediate" level of "development".

This hypothesis could be tested by observing the evolution of IS both in conditions of *reduced* risk/alternative risk management strategies, where one would expect to see a decline in the importance of IS and diversification strategies generally, and in conditions of *increased* risk/reduced reliability of alternate risk management strategies, where one would expect to see increased importance of IS. Good examples of the latter situation are to be seen in parts of Africa, where the costs of intensification are increasing and risk is increasing and there is a tendency to revert to less intensive/more diversified production strategies (see Dounias, this volume)

Technological improvement also leads to the production of industrial substitutes for natural products. Many once-commercially important natural products have been completely or partially replaced by chemical substitutes, including rubbers and other natural latex (*getta percha, chickle, jelutung*), oleo-resins, gums, flavouring agents like vanilla and cinnamon, and essences like sandalwood and rosewood.

Substitution has led to the collapse of many extractive systems. However, while extractive rubber production in Brazil collapsed, smallholder rubber production in Indonesia has consistently increased over the last century. Similarly, where the replacement of damar by industrial resins led to the collapse of wild damar collection in Kalimantan and the abandonment some damar agroforests in South Sumatra, damar agroforests in the area of Krui have consistently expanded until today. The hypothesis might be that IS are more resilient than extractive systems. Managers have more invested and, with more concentrated production and more control over that production (technically and in terms of property rights), they are in a better position to pursue and exploit particular market niches. Moreover, as discussed above, IS provide other non-financial benefits (see also Belcher et al (in press)).

Another issue, raised in several of the cases presented at the meeting, is that there is a lack of official acknowledgement (either legal or technical) of IS. Development plans, policies and regulations tend to favour more intensive land management systems and implicitly or explicitly lead to the weakening or disappearance (if not deliberate replacement through government development plans) of intermediate systems. Crop improvement research has focused on producing sun-tolerant varieties of crops best suited to cultivation in specialized fields, without shade trees. Many farmers have therefore abandoned traditional mixed-systems. IS have not benefited from the technological improvements developed for agriculture or forestry, and have not been supported by extension or other policy instruments.

This lack of recognition of IS by dominant groups in political, science and development arenas, relates to issues of global perceptions of the relation between society and nature, and to the representation of what “development” means and should look like. Perceptions of development and modernity have an important influence on whether or not “intermediate” systems are maintained. We have shown how the western perception of the superiority of grain culture over horticulture has impacted on the development of native forms of forest resource management in the tropics, including IS (for a full development on these issues, see Conklin 1957, Geertz 1966, Haudricourt 1943, Barrau 1967). This dominant perception of a “natural” agricultural development has led to lack of official acknowledgement of indigenous practices –and rights- over forest resources. Indigenous practices for forest resource and agricultural development (including slash and burn and IS) are commonly regarded as “primitive” if not as a threat to the environment (ASB), and the multiple values of such systems are often not recognized. Government efforts often aim to modernize the resource management methods used by local people and move toward more intensive system.

The perceptions of the managers themselves are, of course, important. As intensive systems of forest management or agriculture are typically regarded as being more modern and local systems as “bush work”, local people are inclined to abandon traditional approaches. On the other hand, with new attention to the need for ecologically sound practices for environmental management, intermediate management systems can appear as “green” and be promoted for their technical value. In many of the IS illustrated in this volume, the perception of the systems by the managers themselves has completely changed over the last 10 to 15 years, starting from a feeling of shame for their “primitiveness” to one of pride in their environmental stewardship. This emphasis on the ecologically sound management in IS often serves more socio-political than conservation or sustainable development objectives.

# 5 CONCLUSIONS

To understand the role of IS in the rural economy and assess its comparative advantages, one needs to consider how these system are integrated into the overall household economy and livelihood strategy, their importance in the landscape and in surrounding natural systems, as well as their role in social relations and in political strategies. IS offer diversified income-earning opportunities, with cash income from the main product and as well as producing other cash and subsistence products (foods, fuel, building materials, medicines) from the same area. They provide safety nets as sources of food, cash and medicine during times of need. Many IS serve as means of saving, with a reserve of capital to be drawn from when needed. IS tend to have relatively low labour demands, timing of labour inputs is flexible, and the return to labour is high. These systems fit well in economies in which labour is the limiting factor. And they also fit well as part of an overall land use system, complementing other land uses in *time* (as part of a rotational system, for example), and in *space* (where the location of the farmers forest is determined by the distance to the settlement and the quality of the land). They have important ecological functions (biodiversity, water regulation, carbon storage). They shape and support social relationships. They are an important element in the power relations between local farmers and dominant groups regarding land tenure conflicts and forest development.

But these characteristics of IS only offer advantages under certain circumstances. The important questions are where and under what conditions are IS competitive with alternative landuse systems? Product demand is a key factor, determining the income generation potential and the overall profitability of the system. This was one of the strongest conclusions from the Lofoten workshop: the market for the product, shaping the price level and fluctuations, is a key for the viability of the system. Both rattan and benzoin are examples of systems that have suffered from stagnating markets. Nevertheless, there is an important inertia in IS *vis à vis* market fluctuations: contrary to systems based on short-cycle crops, IS are not immediately abandoned when the market of the main product stagnates or shrinks. They may rebound through the introduction of alternative products (rubber versus benzoin, see above), be maintained in dormancy for many years in expectation of a market rise (this often happened in jungle rubber as rubber market dropped), or maintained for non economic (mainly social or political) reasons (see the examples of damar and benzoin, Michon this volume).

The opportunity costs of labour and land are also important for the evolution of the system The widely held perception that forest extractivism is mainly an activity for the poor reflects their lack of opportunities (low opportunity costs of labour). The dependence on NTFPs other than rubber in the forest in Riau has declined significantly over the last decade, reflecting better income opportunities in other activities. Rubber produced in rubber-based IS remains as one of the more important NTFPs. providing a relatively remunerative and secure income for a large share of the population.

The economic literature suggests that higher land scarcity (or population density) is a major driver towards more intensive land use in a process that moves from extractivism to intensively managed (monoculture) systems. Generally, this phenomenon was *not* observed in the study sites considered at this workshop. The few sites where extractivism appeared to lead to more intensively managed systems, this pattern was primarily interpreted as being a result of (or driven by) large-scale conversion of land use systems due to externally-supported projects (oil palm or transmigration). The cases presented at the meeting indicate that changing output prices, better opportunities, and political factors have been more important than land scarcity *per se* for the development of these systems over the past one to two decades. Although land scarcity may be an important factor in their decline, it did not appear to be a prevalent driving force in the selected IS cases presented at the meeting. A broader comparison of NTFP commercialization patterns (Ruiz-Perez et al, forthcoming) shows that IS are found in relatively remote areas with low population densities, limited transportation infrastructure and relatively low land prices.

Finally, global as well as national policies are essential to the present and future development of IS. Present forest and agricultural policies, as well as broader economic and land titling policies, preferentially support one particular type of development and particular stakeholders to the disadvantage of IS models and their smallholder managers. Intensive agriculture/forestry has developed not only because it was economically profitable, but also because it was politically desirable and supported through an artillery of policies and regulations. Smallholder forms of resource management are rarely supported by governments; on the contrary, policies have contributed indirectly or directly to their stagnation or collapse. The recent emphasis on sustainable development and poverty alleviation (cf. the conclusions of the World Summit in Johannesburg, August 2002) combined with long-standing recommendations and conventions on environmental protection (see the Rio Conference, 1992) gives room for more recognition and promotion of IS throughout the tropics.

# 6 POLICY AND RESEARCH IMPLICATIONS

IS do have a role under the conditions identified above. Moreover, there is evidence that such systems have been overlooked and even discriminated against. Thus, there is potential for both improved local livelihoods and better forest management through further research and development in the area.

As a first step, there is a need both among researchers, policy makers and planners, and the development community in general to recognize the importance of IS to current users.
It is critical to consider whole systems and not view IS in isolation. In many forest-based livelihood systems (not just IS), people rely on a high diversity of forest products, and the actual mix changes seasonally and annually depending on the opportunities available. Interventions should protect (and not compromise) flexibility.

It is common in IS that legal property rights recognition is weak, even if local institutions recognize the rights of managers. Legal support can improve security and thereby provide incentives for improved management and investments.

IS have benefited little from scientific research. There is good scope for improvement through improved silviculture and management, and also through selection and breeding of improved varieties suitable for cultivation in mixed systems.

Important constraints often occur downstream in the processing and marketing chain. Typically, small-scale forest product producers are disadvantaged by weak transportation infrastructure and opaque markets. Producers that are actively managing production in IS may be further disadvantaged by government regulations that were designed to deal with wild harvested products, with unfair restrictions and fees. Identifying and reducing these constraints should be a priority.

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# SECTION 2 - GENERAL OVERVIEW AND THEORIES

# 'INTERMEDIATE' FOREST TYPES AS MAN-NATURE SYSTEMS: CHARACTERISTICS AND FUTURE POTENTIAL

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'Intermediate' forests may be defined as any mixed tree stand, in which species composition has been adapted to suit human needs, but which are still 'nature-analogous' in the sense of preserving most of the structural characteristics and ecological processes of natural forests. They do not form one specific forest type, but include a range of modified and transformed forest types. Modified forests derive from tolerant forest management regimes by which the native vegetation is largely conserved or reconstituted through successional stages; they include natural forest modified by gathering of forest products and selected protection of specific tree resources and resource-enriched natural forests. Transformed forests derive from intrusive management regimes by which the native vegetation is replaced by (mixed) tree plantations that are manipulated by long-term human activities; they include reconstructed natural forests such as agroforests, mixed arboricultural systems and interstitial trees on croplands. The intermediate position of these forest types can be related to their position between natural forests and plantations regarding their vegetation structure and composition, and to their position regarding management intensity between the low intensity of forest extraction systems and the high intensity of plantation systems with selected cultivars. 'Intermediate' forests are also characterised by the fact that they have evolved within local communities rather than having been developed within the scope of professional forest management. They mostly form an element of an integrated local land-use system rather than representing a specialised forestry system. Most 'intermediate' forest types show the following management features:

- The management is multi-resource focused rather than ecosystematic focused. Management is directed at specific forest components in the form of either individual trees or forest patches rather than at spatially-defined ecosystems. Consequently, management is characterised by 'linked' and 'nested' relationships.
- There is a high degree of spatial and temporal variation in management as different forest components may be subject to different management practices and intensities..
- They are managed by a combination of 'silvicultural', 'agronomic' and 'horticultural' management practices;

Consequently, these systems tend to be much more dynamic than professional forest management systems. In view of this dynamic nature, it is difficult to assess their sustainability on the basis of the presently-agreed criteria for sustainable forest management. In assessing the sustainability of these systems it is more relevant to consider the future scope for these systems rather than to focus only on their present state. In the past, the ‘intermediate’ forests were often considered as dating from a traditional past and being scientifically outmoded. However, several recent developments, such as increased appreciation for multifunctional land-use systems combining production and nature values as well as decentralisation in forest management, cause that the scope for further application of ‘intermediate’ forest systems is open to reconsideration.

# RICH IN THOUGHT AND WISDOM, FLOWERS AND FOOD: CULTIVATED FORESTS OF WESTERN MELANESIA

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*Keywords:* agroforestry; arboriculture; archaeology; prehistory; Melanesia; New Guinea; Manus; shifting cultivation; tropical horticulture

This paper reviews aspects of western Melanesian subsistence economies with special reference to traditional forms of forest management, arboriculture and agroforestry, to develop an explanatory framework for a local archaeological sequence. Humans first settled tropical islands of New Guinea and the Bismarck chain to its northeast in the late Pleistocene, initiating a very complex prehistoric record of habitat modification related to subsistence activity. This record includes very early direct evidence for plant foods derived from the forest, deliberate alteration of swamp drainage, island-to-island translocation of biotic and other resources and independent domestication of a number of significant plant foods. There is also evidence against isolation of the region, in a continuing record of selective adoptions of introduced components.

Past and present systems of subsistence production in the tropical islands of western Melanesia show more than enough diversity of practices and resources to defy simple summary. Trees are important components of all these systems, providing a wide range of resources for local consumption and trade, from forests as well as from trees planted or maintained in gardens and villages. The strategies for managing trees represent a continuum between extraction of natural forest products and harvesting of plantation crops. However, this continuum does not correlate easily with other variables of subsistence activity, which often cannot be simultaneously resolved in parallel or analogous series.

Much of the region's present-day food production depends upon shifting cultivation, and detailed descriptions of a few of these regimes suggest diversity in the management of the forests which guarantee the sustainability of garden produce, as well as in techniques and plant associations of the gardens themselves. Forests and gardens are thus intermingled in complex ways in both time and space, and western Melanesia presents a rich mosaic of indigenously developed production systems based upon the management of forests. These systems are at once stable and innovative, resilient and flexible.

It is tempting to arrange the present-day mosaic of forest management practices into a typological series and read the ordering dimensions as evolutionary trends. But contradicting archaeological and other prehistoric data undermine the heuristic value of such trends. Thus much of the present-day diversity is left unexplained. This is particularly true of traditional forest products and tree crops, which, despite their prominence in both the archaeological record and the present-day rural landscape, are poorly understood.

Part of the problem lies with an analytic bias which sees the garden as the focal point, excised from its context which may include both radically different gardens and un-gardened but otherwise productive landscapes. If we fail to grapple with understanding the temporal and spatial dynamics that reproduce these complex traditional systems, they will be destroyed in the name of development. And we will be left with a good deal less biodiversity.

## SESSION 3 - FROM THE FOREST: EVOLUTION OF EXTRACTIVE SYSTEMS, RESILIENCE OR CHANGE?

# THE RESILIENCE OF AGRO-EXTRACTIVE SYSTEMS OF CAMBAS AND CABOCLOS IN THE AMAZON FOREST

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The forest production systems of the *caboclos* in the Brazilian Amazon and the *cambas* in the Bolivian Amazon are characterized by typical agro-extractive strategies. These forest dwelling populations have based their livelihoods on a forest production system that goes back to the rubber boom in the Amazon and has diversified without losing its link with a forest-based economy. This paper addresses peoples' ability to combine small-scale extraction of timber and Non-Timber Forest Products (NTFPs) with subsistence agriculture, hunting and fishing. Both strategies have similar historical roots in rubber tapping and use agro-extractive practices in a lowland forest area. Over time they have evolved along different lines as a result of different local and supra-local contexts.

The paper will address these different circumstances and the consequences they have for the stability and the dynamism of these systems. Historic elements together with economic, ecological and socio-cultural characteristics reveal the factors that are supportive to the resilience of these systems vis-à-vis external forces and the internal evolution that threaten their continuity as 'intermediate systems'. The research is based on field data from the floodplain area around Belém and the northern Bolivian Amazon around Riberalta. The forest dwelling populations in both regions rely on the forest for their economic resources and, at the same time, have constructed socio-cultural environments that perceive the forest as an integral part of their livelihood.

The analysis will show that these systems are under pressure of fluctuating markets for forest products and regional development processes. The driving forces that directly alter the forest production system are urban expansion and large-scale forest exploitation by capitalist entrepreneurs. However, the agro-extractive systems show characteristics that enforce their resilience in relation to these developments. The systems as well as their practitioners prove to be flexible and adaptable to changing circumstances.

# ECONOMIC AND ECOLOGICAL DRIVERS AND CONSEQUENCES OF MANAGING FORESTS FOR NON-TIMBER PRODUCTS

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*Keywords:* non-timber forest products, NTFPs, forest management, intermediate systems, Euterpe oleracea, açaí Amazon estuary, Brazil

Many intermediate systems are managed for species that yield non-timber forest products (NTFPs). Recently, interest has grown in promoting tropical forest conservation through the management and extraction of NTFPs. This strategy, employed in Brazilian Extractive Reserves and many other systems, is envisioned as a way to merge income generation of local people with forest conservation. Achieving the second goal may be difficult, however, because managed forests, by definition, differ fundamentally from non-managed forests. This creates a paradoxical situation in areas such as extractive reserves: for harvest of NTFPs to be profitable, their densities must be increased through management, which alters the structure and composition of the forest that was intended to be conserved. Successful merging of forest conservation with its use for income generation depends upon greater understanding of the causes and consequences of forest management.

Our study focuses on four aspects of the evolution and sustainability of the intermediate system of açaí (*Euterpe oleracea*) management in the Amazon River estuary of Brazil. We consider, in turn, economic and ecological incentives for managing forests at intermediate levels; açaí palm management and economics; ecological consequences of açaí management, and the role that certification of açaí products could play in more sustainable management and harvest of this system.

Numerous socioeconomic, political, and ecological factors influence the intensity of management and harvest of NTFPs. Among the most important are household income, land tenure, and markets. In the case of açaí, the emergence of markets and access to them greatly influence the choices that people make regarding managed species and intensity of harvest. The principle ecological determinant of intermediate forest management is the low density of most NTFP species, which translates to low overall productivity and efficiency of harvest. To increase productivity producers increase densities through planting desired species and removing undesirable ones.

Neither ecological nor economic factors that influence intermediate systems can be adequately viewed in isolation from their ecological and economic contexts. For example, current decisions of managers might have less to do with current market situations and more to do with previous experiences with market fluctuations. Many species with low current economic values are maintained in intermediate forests in the event that markets for them grow in the future. Context also matters for ecological factors; the presence of non-managed forest from which other NTFPs can be gathered influences whether those species are tolerated or removed from intermediate forests.

Acaí palms yield two of the most culturally and economically important NTFPs in the Amazon: palmito (heart-of-palm) and acaí fruit. Açaí is multi-stemmed, so individual stems can be harvested annually without killing the tree. In 1996, 86.080 tons of palmito were canned, exceeding $US13 million in value. Açaí fruit is harvested by climbing stems and removing the clusters of fruit. The fruits are then processed into a juice. In Belém, the largest fruit market, nearly 152.000 tons, valued at $US20.3 million, is sold annually. Acaí occurs naturally at low densities, but its abundance is increased through management activities, including planting and relocating seeds and seedlings, weeding understory competitors, and removing shading canopy trees. Forests dominated by acaí cover an estimated 10.000 $km^2$, so ecological consequences of acaí management and harvest likely has large-scale implications.

Forests managed for açaí production differ from non-managed forest in several important ways. Managed forests support higher densities of açaí and lower densities of hardwood trees, vines, and lianas. This results in a more open understory, lower canopy, and reduced canopy density - all changes that likely cause managed forests to contain significantly more fruit-eating birds and fewer understory insect-eating birds. Although they are managed at intermediate levels, acaí forests function more as plantations in terms of their role in conserving biodiversity.

The high market value of açaí products could be used, through certification, to increase the biodiversity value of açaí forests. Knowing that the loss of forest-like characteristics is the major factor altering forest and bird communities in açaí forests, management that maintains those characteristics should be encouraged; through certification, producers that do so would enjoy higher profits from their products. The açaí system exemplifies the need for both economic and ecological data in intermediate forest management.

# FOREST EXTRACTION OR CULTIVATION? LOCAL SOLUTIONS FROM LAO PDR

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Lao PDR is a unique country in the Southeast Asia region, with a high dependency on forest products, due to its low population density combined with a high rate of forest cover. Non-Timber Forest Products (NTFPs) provide 50% of cash income of rural villages, where 80% of the Lao population lives. Local subsistence use of NTFPs may account for 20-30% of the Gross National Product. While free extraction remains the main mode of forest use, local communities have developed some interesting "intermediate" forest management systems.

We can discern a breakdown of typical traditional intermediate forest management systems, e.g. shifting cultivation, privately owned trees in common forest e.g. yang oil trees (*Dipterocarpus alatus*), holy forests and hunting taboos. The key factors causing the decline of these systems are the rapid population growth and massive population movements during and after the war of 1964-1975, disruption of traditional social structures, rapid conversion of forest to agricultural land, increased timber production, low prices for both timber and non-timber forest products (NTFPs), and a growing insecurity on land tenure and access rights.

On the positive side, a number of new systems are also evolving, e.g. agro-forests based on domestication of NTFPs, community based aquatic resource management, (single-) community based NTFP harvesting rules and multi-village NTFP conservation rules. Examples are given of domestication of cardamom (*Amomum villosum*), 'si siet' bark (*Pentace burmanica*) and broom grass (*Thysanolaema maxima*), harvesting rules for rattans (*Calamus* sp.), wildlife and fish, marketing of edible 'bitter' bamboo-shoots (*Indosasa sinica*). The key factors that drive this process of local intermediate forest development are the importance of NTFPs in the rural economy, the wealth of 'indigenous technical knowledge' on NTFPs and forests, increasing market penetration, innovative and enterprising attitude of local forest users and the support of facilitating projects/programs.

These systems could be a very good basis for sustainable, community based forest management. They provide local adaptability, a good risk aversion strategy, nutritional diversity, a safety net function in times of emergency and a stimulus to social cohesion. They also provide a basis for food security and poverty alleviation, they give strong incentives for biodiversity conservation and they contain potentials for the development of a strong and sustainable forest-based industrial and trade sector.

Local people can develop solutions, but often they can only do so if they are assisted by strong exchange networks of technical and market information exchange networks. Typical examples of elements of such networks for information exchange are the use of participatory techniques (RRA/PRA), on-farm and in-forest research trials, working closely with existing social/administrative structures, planned regular evaluation/feedback events, sharing lessons learned through workshops, technical papers and reports, village-to-village study tours, participatory decision making processes and group building approaches at village and multi-village level, etc. A case is made for local experimentation and local knowledge as the key factors to create sustainable forest use systems. Researchers should tailor their programs to the needs of local forest users.

# HAND-MADE BARK PAPER IN MEXICO, LOCAL PRODUCTION - REGIONAL HARVEST: TRANSITIONS IN TREE-KNOWLEDGE, EXTRACTIVE STRATEGIES AND LAND USE SYSTEMS

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In Mexico, socio-economic, cultural, political and environmental changes at local, regional, and national levels are causing considerable impacts on rural landscapes and peoples and their ecologies. Among other changes, the decline of agricultural activities related to the depletion of subsidized prices of staple goods is causing massive migration and the intensification of off-farm activities. Craft production and its related natural resources-extraction are emerging as new commodities. This case study analyzes such processes at local level. The paper discusses the underlying socio-cultural and ecological factors behind the local production of a hand-made bark paper in the Otomi indigenous village in Central Eastern Mexico along with the regional extractive system of the various barks that provide the raw material.

Hand-made bark paper manufacturing in Mexico has a long history of more than ten centuries, but its production as a handicraft began only in the 1960s A complex commodity chain developed in a relatively short time period, engaging diverse new social actors at national and international levels, ranging from indigenous craftworkers, regional bark harvesters, local middlemen, wholesalers to the end-consumers. As hand-made paper demand increased over the last 30 years, the bark harvest area gradually expanded, involving peasants who temporarily engage in bark harvest as an alternative income activity.

At present, the bark area covers around 1,500 $km^2$ and varies according to local ecological and socio-cultural patterns. Extractive strategies are linked to agricultural activities, religious festivities and climatic conditions during the annual cycle. These strategies vary in terms of labour organisation, tree-growth site selection, bark-tree species management, and the volume of the harvested raw material.

Both, Otomi craftworkers and regional harvesters are continuously experimenting with different tree species as potential sources of bark. Of the 13 tree species used, seven were adopted during the last 30 years, while the other six, mainly *Ficus* sp., have been traditionally managed since many centuries ago. *Ficus* trees are sacred according to Otomi indigenous craftworkers; their bark is mainly used to manufacture ritual paper for their ceremonies, and their harvest techniques lead to bark regeneration. In contrast, the tree knowledge of regional harvesters centres mainly on only one of the bark tree species, *Trema micrantha*, a tropical pioneer tree that supplies the highest volume of bark material. Its management correlates with the different regional land use systems, mainly shifting-cultivation and shaded coffee plantations. Recently, some harvesters are carrying out innovative *Trema micrantha* purposeful management (seed collecting, planting and seedling transplanting) within the shaded coffee plantations.

Approximately 30% of the harvest region is covered by coffee plantations, most of which occur as shade grown plantations. Due to their ecological complexity and multi-purpose management these plantations play substantial role in indigenous peoples' subsistence strategy. They also are highly biodiverse natural reservoirs, representing the only remaining forest patches. Today, hand-made bark paper production depends on the regional shaded coffee plantations where *Trema micrantha* trees occur as part of the tree shade.

# WILD OR DOMESTICATED BIRD? SWIFTLET KEEPING IN INDONESIA

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Tropical swiftlets (*Collocalia sp.*) produce nests with their saliva. The Chinese consider these nests a delicacy and a powerful medicine. In Indonesia, local people have been harvesting nests in caves and trading them for many centuries. Although cave harvesting is still practiced, most production today is artificial. The first steps in the domestication of swiftlets occurred about two hundred years ago on the northern coast of Java. It began with ‘accidental’ intrusion of birds into houses or warehouses. Then people started developing specific knowledge. This knowledge remained, however, restricted and rather secret until very recently. Then suddenly, since the early 1990s, swiftlets continued to spread to many places in Indonesia. China’s economic development stimulated this change. Demand increased because many new customers could afford to buy this luxury product, which can reach US$ 3 000/kg in Hong Kong markets.

Successful swift keeping depends on recreating artificial conditions similar to the birds’ natural habitat: darkness, constant temperature (28°-30°), humidity, and security from predators. They also need to have free access to food (flying insects) at several locations outside from their roosting positions. So far no one has been able to breed these birds in captivity, even when providing food. Swiftlets need to remain free and spend many hours a day flying and hunting insects.

The birds, which choose the artificial habitat, are “voluntary guests”. This means that at any time they can leave and move to a more suitable place, either a natural cave (if available) or another location. The challenge consists in convincing the birds to stay in one place, and successful keepers had developed specific knowledge to accomplish this.

These conditions of the bird’s mobility have some similarities with bee and pigeon keeping, which makes it more convenient to use the word “keeping” instead of “breeding”. Breeding represents a higher level of control over the animals.

The main activities in swiftlet keeping are habitat arranging, food supply, and reproduction. Some, like habitat arranging, do not imply any direct manipulation of the bird. Others activities, like exchanging eggs of one species with those laid by another species, represent a higher level of intervention since it requires direct manipulation and selection.

Observations in the field also show many differences among keepers regarding technical choices and investments. There is presently a tendency toward “professionalisation” of swiftlet keeping with larger investments and introduction of more efficient technology. In fact, production per house is higher (reaching 40 kg in the new kind of buildings). Global production for the country seems to have increased exponentially over the last fifteen years, indicating that the methods are successful and generate large incomes.

Although many swift keepers are trying to attain a higher level of control, which would include “breeding”, the birds still resist. The present semi-domestication is still a reversible process. Birds can return to the wild when suitable conditions are available. Swiftlets kept in houses are still not ethologically or genetically different from those that still live in caves.

Swiftlet keeping should help reduce pressure on natural cave birds because production from an artificial habitat is growing very fast, first quality ‘house nests’ are more expensive than natural origin ones, and customers from Hong Kong and China seem to prefer ‘house nests’. However, demand for both kinds of birds is larger that the present supply and prices of cave nests are still high enough to incite harvesting. In many locations, conflicts have occurred over cave exploitation rights. This confusion and lack of security discourages sustainable management.

# SESSION 4 - EVOLUTION OF INTERMEDIATE SYSTEMS: ISSUES, PROCESSES AND DETERMINING FACTORS

# INTERMEDIATE SYSTEMS: A CONCEPT FOR SUSTAINABLE DEVELOPMENT? CASE STUDIES FROM BRAZIL AND LAOS

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Intermediate Systems is a concept now deployable from the sustainable development toolbox. The sustainability paradigm itself is a vision of the world unified by scientific rationalism. It postulates the pursuit of the "real existing development", but without irreversible planetary damage. Models and solutions are thus sought and mobilized to support such an objective. In the cognitive framework of scientific modernity, such models and solutions need to be consensual, effective, technical, utilitarian, and universal. But these models may well have only the slightest correspondence with specific local situations, or with the worldview of the supposed experimental populations.

Intermediate Systems have in common their being quasi-exclusively founded on the appropriation and domestication of Non Timber Forest Products (NTFPs). However, it is not easy to encompass all the various modes of NTFP exploitation. The particular forms of NTFP in specific places at specific times are a function of both the economic and ecological systems, power over land tenure, available tools and technologies, and ability to mobilize the labor force.  This leads to the question of how may Intermediate Systems appear as development models?

This article intends to show:

• How the sustainability paradigm has allowed perceptual changes and a more global approach to agroforestry systems? We've passed from one social construct to another: previously from a transient situation *en route* to modernity and economic development, and presently of native agroforestry systems becoming solutions for attaining sustainable development. Among the quite disparate situation are extractive reserves, flexibly managed forests, and agroforestry systems more generally. All these concepts now seem to fall under the rubric of intermediate systems, and all seem to have aroused new interest on the part of development professionals. Why?

• The agroforestry systems that we have studied in the Brazilian Amazon (Extractive Reserves) and in Laos (slash and burn cultivation) must be analyzed from the outset as social constructs prior to being put forward as the basis for any sustainable development models. Otherwise, we stand at risk of providing, in the guise of environmental policy, camouflages over the struggle between various interested players. We risk implementing maladaptive policies derived from our own misinterpretation of reality.

# FOREST DOMESTICATION BY SMALLHOLDER FARMERS: ECONOMIC RATIONALE OR SOCIO-POLITICAL STRATEGIES?

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*Keywords:* Forest domestication and management, peasants, patrimony, access and use rights, power, conflicts.

Intermediate systems of forest management can be interpreted as original attempts of domestication of forest resources by local people. What do we know about the significance of the emergence, adoption and generalization of this particular domestication process? What do we know about its main driving forces? The emergence and generalization of domestication dynamics in the history of human societies has been mainly attributed to economic, ecological or technical factors. However, this analysis is mainly based on examples of domestication for short-lived plants -grains and tubers- or animals in greatly artificialized ecosystems. How far do these conclusions hold true when transferred to long-lived forest plants in relatively preserved forest ecosystems?

The emphasis put on economic value of tropical forests during the last decade tends to conceal the important social and political dimensions of forest management. Forests are a determining element in the building of societies, as well as in the forging of relations between the various segments of societies. From the historical analysis and interpretation of the global trends in the emergence and extension of forest domestication in the world, one can argue that economic and technical factors, though important at one point in time, might not constitute the only driving force towards massive adoption of the domestication innovation in a given society, but that social and political factors are more important.

Historical accounts clearly show how forests all over the world have been extensively used by the all segments of societies, not only to improve their economic welfare, but also to claim, establish or change their respective social and political as well as economic place and role in the society. A relatively constant factor in the relations of power between the governing elite and economic actors has been the constraints imposed upon the latter -specially the weaker ones- by the former regarding access to and use of forest lands and resources. In this respect, any attempt of forest domestication has to be analyzed in its relation to the impact it has upon access and use to forests for the social actors who have induced this process. This analysis necessarily implies discussing the social and political dimension of forest domestication.

The argument of the importance of this socio-political dimension in the evolution towards and from intermediate forest management systems is discussed through the review of several examples of forest domestication by peasant societies in Europe and Indonesia. These examples reveal that domestication and production of forest resources by politically fragile societies clearly represent strategies for control and appropriation of forest resources. This appropriation process reflects either an internal social strategy, like the construction of a patrimony or the quest for social rise in a local context, or a political act conducted in anticipation of or as a reaction to restriction or seizure of rights to the "traditional" forest domain and resources of the peasants by external actors.

The paper concludes with a more theoretical discussion about the respective significance of technico-economic rationale versus social and political logics for long-term forest production in the particular context of smallholder production systems.

# RESILIENCE AND EVOLUTION IN A MANAGED NTFP SYSTEM: EVIDENCE FROM THE RATTAN GARDENS OF KALIMANTAN

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The rattan gardens of Kalimantan provide an excellent example of an intermediate NTFP management system. Rattan, cultivated as part of the traditional swidden agricultural system, has long played an important part in the local and national economy. It has provided an important source of cash income for farmers, and the raw material has been a major source of internationally-traded rattan raw material and, more recently, the basis of a strong domestic furniture and handicrafts industry. The system is well adapted to the local economy and ecology. However, over the past two decades, important changes have taken place have tested the resilience of the system. A combination of government policies designed to encourage the domestic processing industry and monopsonistic manufacturing association have sharply depressed demand and prices. New developments in the region, in the form of roads, industrial plantations, mining, and other new economic activities, have both actively displaced existing rattan gardens (« push » factors) and offered attractive alternatives that have led some rattan farmers to shift to new activities (« pull » factors). And, recent widespread forest fires have destroyed large areas of rattan gardens, effectively forcing some rattan farmers out of business. This set of conditions offers a good opportunity to study peoples' responses and to analyze whether and under what circumstances this particular intermediate forest product management system is a viable economic option now and in the future, and to draw more general lessons about intermediate management systems for forest products.

The rattan gardens system and the general social, economic and landscape conditions have been under study by a consortium of researchers from several organizations. This analysis draws on a range of data from this research, including a survey of villages in the region, detailed household surveys, ecological/agronomic studies, economic studies, and remote-sensing based land-use change analysis and spatial analysis. The primary analytical approach is a comparison of inter-temporal and inter-spatial differences in the importance of rattan in household economic strategies. We test the hypothesis that changing social and economic conditions are making rattan gardens relatively uneconomic, leading to the ultimate abandonment of the system.

Under current conditions, with low prevailing demand and prices, rattan gardens offer relatively low financial returns per unit of land. However, rattan gardens remain important where competition for land is low because they fit well with the swidden cultivation system that is the economic mainstay in the region, because they have low establishment and maintenance costs, offering high returns to labour. The rattan gardens provide a mark of land “ownership”, and they serve an important purpose in risk management and as a means of “savings”. Moreover, rattan gardens provide valuable ecological services, in terms of biodiversity conservation and other forest functions. As rattan remains an important commodity in Indonesia and internationally, and as the current farm-gate price for rattan appears to be artificially low, due in large part to the prevailing policy environment, the rattan garden system may remain viable, at least in the medium term. The paper concludes with policy recommendations designed to level the playing field for the rattan garden system.

# THE ROLE AND DYNAMICS OF COMMUNITY INSTITUTIONS IN THE MANAGEMENT OF NTFP RESOURCES IN CAMEROON

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To understand the nature of 'intermediate' forest management systems in the continuum of extractivism from natural forests and cultivation of trees in plantation management, it is important to consider both their technical and institutional features and relations to forest structure. The present study aimed to gain insight into the role and dynamics of community-based institutional and regulatory frameworks with regard to NTFP resource exploitation and management in the humid forest zone of Cameroon. It was particularly focused on the relations between increasing commercial value of NTFPs and exploitation and management intensities on the one hand, and the social sustainability of community based institutions on the other. A comparative study on six pre-selected NTFP species was undertaken. Three research sites were selected that are comparable with regard to ecological conditions and local utilization of the six selected NTFPs, but different in respect to four factors that can have an impact on the intensity of NTFP resource exploitation and management: (a) availability of NTFP resources; (b) market access (i.e. degree of isolation); (c) population density and (d) presence of non governmental and private agencies (e.g. development and conservation organizations, logging companies). In each site, three representative research villages were chosen. It was expected that the selected NTFP species occurred, and were commonly used and marketed, in at least two of the three sites. Moreover, they had to be extracted from various habitats (ranging from natural forests to plantations) and their exploitation had to represent different levels of risks for unsustainable harvesting. The following NTFP species were included in the study:

| | | | |
|---|---|---|---|
| (1) | *Irvingia gabonensis* | (4) | *Garcinia lucida* |
| (2) | *Elaeis guineensis* | (5) | *Garcinia kola* |
| (3) | *Baillonella toxisperma* | (6) | *Coula edulis* |

The survey method consisted of interviews with individual villagers based on questionnaires. The questions covered NTFP utilization and its purposes, the relative and absolute importance of the six selected NTFP species, and the construction of different sets of property rights to the selected NTFP species. Semi-structured interviews were carried out targeting individuals and groups to obtain information on socioeconomic conditions in the pilot villages, as well as on their social and political organization. In total 237 villagers (109 men and 128 women) were interviewed more or less equally divided among the research sites. The fieldwork took place from November to December 1999.

The major conclusions can be summarized as follows:

There exists considerable variation in utilization, commercialization, exploitation and management practices between different areas in southern Cameroon on the one hand and between the selected NTFP species on the other. In the most densely populated and most accessible area, there was both a tendency to abandon the exploitation of commonly used NTFPs and to buy these products, as well as to intensify their commercialization. There was also a shift in production areas from natural forests to human-made production systems according to the degree of forest degradation.

The level of application of management techniques was low and differences in management intensities between the three areas were relatively minor. This is in contrast with the expectation that an increasing exploitation pressure and a reduction of suitable forest habitats would lead to a more intensive management in modified forest like systems. The intensity of management was strongly related to specific NTFP resources. The oil palm, *Elaeis guineensis*, with various and competing uses, was the only species for which clear harvest controlling practices existed. The highest valued and less common species, *Irvingia gabonensis* and *Baillonella toxisperma* appeared to be most intensively managed in terms of purposeful propagation. Tenure in NTFP resources, at least for the selected set of NTFP species and their utilization, was primarily shaped by customary land tenure arrangements. In all three areas, land right holders were limited by secondary user rights to NTFP resources located on the land, except for the case of the oil palm, *Elaeis guineensis*. The distribution of secondary user rights differed between and within the research areas and varied according to land types. The group of people holding user rights to NTFP resources was always larger than those people who held the right to control and manage access, exploitation and production, but there were differences at the level of individual NTFP species.

Different levels of local organization are involved in the management of NTFP resources. Customary tenure regimes create multiple, overlapping individual and group rights on the same area (either natural forests or agricultural land) or individual NTFP resources. These rights are vested at different levels of social organization varying from the individual, to kin-based groups (such as lineage and lineage segments, and households), to villages. In all three areas, neither village communities, nor other local units hold exclusive rights over NTFP resources, but there do exist important ethnic differences.

- The distribution of user rights to resources on agricultural land is strongly related to the way the land was acquired. For inherited land the group of users is larger than in case the land was created by clearance. In the area around Yaoundé, most rights are concentrated in the individual. However, the broad distribution of user rights during high production periods in this area suggests a strong resilience of customary property perceptions and relations in a context of changing socioeconomic and land use conditions.

- It is common in the three areas that labor inputs, in particular improvements to the land of a long-standing nature, strengthens individual management rights to land and NTFP resources. Planting of NTFP trees creates most individual rights, including exclusive user rights.

The study did not reveal clearly that the extent of forest degradation and related decrease in availability of wild NTFP resources, or the presence of favorable economic conditions influences the level of applied NTFP management techniques. These results suggest that more research is needed to evaluate the importance of land use conditions (in particular land availability and tenure security) and cultural factors (in particular local perceptions on NTFP management) as major determinants in the process of degradation or intensification of NTFP production systems.  Furthermore the variation between particular NTFP species in terms of management practices and intensities, calls for the establishment of species-oriented NTFP development approaches and not only a production system approach.

# COCOA PRODUCTION IN CAMEROON: FROM CASH-CROP PLANTATIONS TO AGROFORESTS

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Central and Southern Cameroon are known to form an old centre of cocoa cultivation, which was massively introduced in the beginning of the century by the colonial administration. Most of the plantations that are still in production today were created during 1920's and 1930's. Cocoa trees are old and yields are globally low.

Cocoa plantations of Central Africa have always been understood simply as cash-crop monocultures by agricultural services. This perception has served policies aimed at maximizing cocoa yields, via (i) rehabilitation of old plantations (complete substitution of old trees by juveniles, following precise agronomic standards) and (ii) intensification of plantation (adoption of selected high-yield cultivars, and elimination of any other tree susceptible to cause overshading). Agricultural policies are driven by international market rules, which assert that intensification is the only way of saving cocoa production in this region.

Nevertheless, farmers are reluctant to conform to such initiatives. Cocoa plantations of the old centre are in fact true agroforestry systems in which cocoa and dominant trees are closely intermingled. Some of these trees are remnants of the pristine forest and were maintained during the creation of the plantation, some are light-demanding species that established during the fallow period, and others were voluntarily transplanted or even introduced into parcels by farmers. Most of these trees - a mixture of native and exotic species - provide non-timber forest products.

Because the association of cocoa with trees is substantially reduced in areas where cocoa production began more recently (such as the western province of Cameroon), the ecological need for shade of old cocoa cultivars was stressed to justify such associations. Because this ecological "alibi" no longer applies for newly selected cocoa cultivars that are self-shading, the specter of fungal attacks favoured by over-shading is put forward to persuade farmers to eliminate the dominant trees.

The historical context of cocoa introduction in Central Africa shows clearly that the incorporation of trees was justified not only by ecological needs of cocoa. The presence of trees was mainly motivated by drastic changes concerning (i) the socio-cultural organisation (fragmentation of production units, from extended families to nuclear household) and (ii) land tenure (progressively, the temporary usage right on land has turned into permanent land ownership). These changes were directly induced by sedentarization, pacification, taxes and hard labour imposed by the colonial administration. Today, plantations do not exceed 2 hectares and are managed independently by households. The decrease in land availability, combined with a growing monetary economy, have encouraged more individualist attitudes and have increased competition for land access.

Since their origins, cocoa plantations of southern Cameroon have combined three economic perspectives: that of cash crop (standing reserve in case of need for cash, payment of taxes and consumable goods), that of producing NTFPs (local and self-sufficient economy), and that of land tenure perspective (permanent land ownership). By maintaining such an integrated system, farmers reject the dictates of the market, which does not consider any of these perspectives. They express massively a preference for an optimized intermediate system, rather than a monospecific cash-crop plantation corresponding to productivist models.

# INTERMEDIATE FOREST MANAGEMENT SYSTEMS IN TROPICAL MOIST FORESTS IN THE CHIMALAPAS REGION, OAXACA, MEXICO: THEIR EVOLUTION, SUSTAINABILITY, AND IMPACT ON FOREST ECOSYSTEM AND LOCAL COMMUNITY HEALTH

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The Chimalapas region is located the state of Oaxaca in southeastern Mexico and comprises a total of almost 600,000 ha. This region is considered one of the largest remaining intact areas of tropical moist forests in Mexico, and supports exceptionally high levels of biodiversity and endemism, largely due to the high degree of climatic and topographic variation, combined with the presence of both holarctic and tropical elements. The region is also characterized by tremendous cultural diversity, and is home to at least seven different ethnic groups. Systems of forestry, agricultural production, and livestock management in the Chimalapas region reflect a gradient of different intensities in terms of the degree to which the natural ecosystem's processes and functions are changed through human land use practices. In this paper, we identify and define "intermediate forest management systems" within the context of low intensive systems based on extraction of naturally occurring forest resources, ranging to highly intensive systems involving the permanent or semi-permanent conversion of forest ecosystems to other land use systems, such as agriculture and grazing lands. We also emphasize the importance of defining "intermediate systems" within the specific contextual conditions of the natural ecosystem and human-environment interactions at a particular site.

Specifically, in this paper we focus on two intermediate forest management systems which appear to have a high degree of potential for maintaining the sustainability and health of both the natural and human systems in the Chimalapas region: (1) the extraction of valuable timber species (e.g., *Cedrela odorata* (cedro), *Swietenia macrophylla* (caoba), *Guarea glabra* (nopo), *Calophylum brasiliense* (barí) utilizing intermediate technologies based on chainsaws, extraction with mules, and the reliance on a high level of manual labor, and for which there exists significant trade-offs between the efficiency of resource utilization and the conservation of ecosystem biodiversity and functions, and (2) agroforestry systems that either utilize existing forest ecosystems by actively improving the availability of desired species (i.e., *Chamaedorea* palm species), or are based on a rotational slash-and-burn system which allows for sufficient period for ecosystem recuperation and utilizes various products during different stages of the natural successional phases. Both the timber extraction and agroforestry systems mentioned above are considered as being intermediate because they maintain the integrity of the original forest ecosystem in space and/or time, while simultaneously have the capacity to meet local needs of the communities.

A critical analysis of the driving factors determining the transition of these intermediate systems to more intensive land use systems is presented. As part of this analysis, we discuss a case study where appropriate conditions have been created for facilitating the stability of such intermediate systems, and a second case study where attempts to maintain and promote intermediate systems have thus far failed to achieve their objectives. Factors related to the particular sociopolitical, ecological, economic, and historical context of the Chimalapas region are discussed in terms of their influence on the evolution and sustainability of various intermediate forest management systems. Finally, the interaction of human land use activities with natural large-scale disturbance events such as drought and fire are considered, focusing on the long-term implications of these interactions for setting ecological and social constraints on the sustainability of intermediate forest management systems.

# FROM FALLOW TO FOREST: EVOLUTION OF BENZOIN GARDENS MANAGEMENT

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In North Sumatra, most present benzoin gardens were planted in the forest. Reports from colonial Dutch foresters mention this system but describe more commonly the establishment of benzoin gardens in dry rice fallows. Why did the forest gardens take over the fallow gardens? How did they evolve? Which forces are driving the system: the market or socio-political factors? What are the present trends?

Two main species are cultivated in North Sumatra: *Styrax benzoin* is light-demanding in its first stages, and grows naturally under 1000 m. This was the species most frequently planted in rice fallows. *Styrax paralleloneurum* grows better under shade and at higher altitude. It can be planted in rice fallows but grows better in the forest. The two species have gone through different phases of expansion and displacement.

Benzoin gardens possibly emerged a few centuries ago due to a higher market demand. Benzoin resin, used in Sumatra since ancient times, was originally collected in the forest. It had been exported around Asia for several centuries, but the trade may have expanded with the arrival of Europeans in the XVI$^{th}$ century. Benzoin gardens were first described in the late XVIII$^{th}$ c., in rice fallows near the coast.

Benzoin gardens expanded rapidly over the XIX$^{th}$ c., linked to colonization of forest lands for slash and burn agriculture. Benzoin trees of both species were then planted in dry rice fields according to altitude, but *Styrax benzoin* was more common. They indicated the appropriation of a land. Benzoin rather than other trees were planted, as the price for resin was high, but it started decreasing in the late XIX$^{th}$ c. Yet, after the Dutch achieved full control of the region in 1907, massive planting (probably of *Styrax paralleloneurum*) occurred in the highlands, either because the market developed or for land appropriation, since the colonial government limited the access to some forest lands. In the meantime, benzoin was being displaced from the lowlands by another intermediate system, « jungle rubber », and from the flat valley lands, by an intensive system, irrigated rice agriculture. By the 1940's, *Styrax benzoin*, adapted to flat lands and low altitude, had ceased to be the main traded species.

After Indonesia Independence in 1945, highlands communities massively planted benzoin trees (mainly *Styrax paralleloneurum*) to secure forest lands, about to be declared national lands. Present gardens are the result of this action. Afterwards, it was prohibited to cut the forest for slash and burn agriculture. As benzoin trees are not very productive in degraded fallows, they were rarely planted any more in dry rice fields. Farmers still planted trees in the 1970's, as the market was flourishing again, but since then, benzoin price has been decreasing. Coffee and cinnamon started displacing it. Since the 1990's, annual crops, more lucrative and cultivated closer to the villages, have been favoured. Benzoin gardens are progressively being neglected by aging and discouraged farmers. Presently, few people still plant benzoin trees. As they are facing land limitation, they adapted to a new system: rejuvenation of old gardens.

The emergence of benzoin cultivation, the choice of cultivating benzoin rather than other plants, the displacement of benzoin by other crops have been driven by market forces. But, at different times, benzoin planting has been stimulated by land colonization and appropriation. Forest gardens are the result of one of these processes, while the fallow planting system disappeared because of land limitation. Presently, benzoin gardens are in recession, benzoin price is lower than before, farmers and gardens are old, and work in the forest is seen as backward. Giving value to this intermediate system would stimulate its recovery. Otherwise it could disappear.

# FOREST PRODUCTS FOR THE POOR, THE RICH, OR THE MIDDLE CLASS? THREE CASES FROM INDONESIA

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This paper investigates how forest dependence – defined as the share of total household income derived from forest products – varies with total income. The empirical evidence is from household surveys in Riau, North Sumatra and East Kalimantan provinces in Indonesia, which were done as part of the FORESASIA project.

Forest dependence is a function of a number of factors in addition to total income (age, availability, alternative income opportunities, local institutions, etc.), as well as the characteristics of the products/systems. First, for low yield extractive products, characterized by open or easy access and small skill and capital requirements, one can hypothesize that the poorest households will have the highest forest dependence. Low-yielding forest products become an ‘employer of last resort’.

Second, intermediate systems often require more investments, access to land, and long-term investments. These characteristics can exclude the poorest groups, while the systems limited profitability and the type of work involved can make them unattractive to the well-off households. Thus we hypothesize that IS is most attractive to the middle income groups. Third, some high value products are characterized by high capital investments and/or restricted access (based on, for example, political connections), and might be only feasible for the richest households.

The findings give some support to these hypotheses, as shown in the table below. The households in each area were divided into three equally sized groups based on total household income. Collection of various non-timber forest products (NTFP) in the Seberida district in Riau has clear in pro-poor characteristics, with the income share for the poorest third being about two times the share for the two other groups.

Benzoin, rubber and rattan can all be characterized as intermediate systems, but only benzoin in North Sumatra has the clear middle-class characteristics. Rubber (Riau) is equally important for the poor and the middle-income groups. Good land availability and being a relatively low-tech system have made rubber the most important income source also for the poor. Rattan does, however, have many similar characteristics, but the picture from East Kalimantan is different. The small income shares (and a small sample size) should nevertheless make us careful to draw and firm conclusions.

Finally, both timber (Riau) and honey (East Kalimantan) can be characterized as high-value forest products, and both show a clear pro-rich profile. The richest third of the households have a timber income share that is about four times that for the poor and middle-income households. In absolute terms the difference is, of course, much larger – the richest third earns 36 times more from timber than the poorest third.

| **Product** | **Income group** | | |
|---|---|---|---|
| | **Low** | **Middle** | **High** |
| NTFP (Riau) | 9 | 5 | 4 |
| Benzoin (North Sumatra) | 13 | 23 | 8 |
| Rubber (Riau) | 73 | 74 | 33 |
| Rattan (East Kalimantan) | 2 | 1 | 8 |
| Honey (East Kalimantan) | * | ** | *** |
| Timber (Riau) | 4 | 5 | 19 |

The causal link between total income and forest dependence does not only run from total income to forest dependence. Timber is clearly an example where the money involved is so high that those involved will normally not be classified as poor. Further, an argument can be made for both benzoin and rubber that these intermediate systems have helped moving rural households from the poor to the middle-income category.

# GAP REPLANTING - AN EMERGING TREND IN REJUVENATION OF JUNGLE RUBBER AGROFORESTS IN JAMBI, INDONESIA

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As an intermediate system between natural forests and man made plantations, jungle rubber (*Hevea brasiliensis*) agroforestry is a predominant land use system in Sumatra and Kalimantan in Indonesia. Within a century after the introduction of rubber into Indonesia, nearly all food-crop based shifting cultivation has now been replaced by rubber-based agroforestry in the lowland peneplain zone of Sumatra. Lessons learnt from this development of rubber agroforests are of much interest for other regions of the world where food-crop based slash and burn agriculture has become unsustainable. In addition to providing cash income for the farmer, jungle rubber agroforests, with a high biodiversity value, also provide a range of non-rubber products and environmental benefits.

As an alternative to the rotational agroforestry involving slash and burn at the beginning of each cycle, gap replanting (locally known as *sisipan*) is emerging as an important, farmer identified method of gradually replacing senescing rubber trees with new plants. The approach is more like de-intensification of the jungle rubber system and leads to a more varied age structure of trees in a 'permanent' rubber agroforestry.

A study is reported here that aimed to identify factors that influence farmers' choice between intensive slash and burn and replant at field scale or less intensive *sisipan* (interplant) at patch scale in old jungle rubber agroforest. Individual farmer interviews were followed by group discussions in five villages in Jambi province. The identified factors included capital investment for starting a new cycle, labour constraints, land scarcity, risk from vertebrate pests, and production status. Monetary costs and gains coupled with perceived risks, seem to be the primary driving factors although non-economic factors cannot be neglected. Farmers' perception, technological developments, socio-political determinants are likely play important roles in choice between intensive and less intensive systems. However, adoption and sustainability of the gap replanting method of rejuvenating jungle rubber agroforests, and its potential as an alternative to slash and burn approach, will very much depend on its tangible economic returns. The paper also includes a brief economic comparison between various rubber production systems and results of a species richness study carried out in Jambi.

# TEA MIXED PLANTATIONS AND HOME GARDENS AS SUSTAINABLE INTERMEDIATE SYSTEMS A CASE STUDY IN THE WET ZONE OF SRI LANKA

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Deforestation, forest fragmentation and agricultural expansion threaten the conservation of biodiversity in the Wet Zone of Sri Lanka. Agriculture is one of the main sources of income in Sri Lanka. The high income, easy access to markets, and availability of labor have encouraged people to convert large land areas into monoculture plantations. Trends of increasing cash crop plantations, especially tea and rubber monocultures in the lowland Wet Zone, create sharp barriers between forested and non-forested areas which often limit the distribution of wildlife. However, there are some intermediate systems existing in the region such as home gardens and mixed crop systems. These intermediate systems facilitate to the distribution of wildlife and maintain biodiversity to a greater degree compared to monoculture plantations.

This research examined the hypothesis that conversion of monoculture cash crop systems into mixed crop intermediate systems may enhance ecological sustainability by maintaining greater structural and species diversity in the landscape. Land use systems considered in this study were grouped into three categories: monoculture plantations (tea, pine and rubber), intermediate systems (mixed tea-plantations and home gardens), and mature forest systems. Ecological sustainability was evaluated in the different land use systems using both vegetation indicators (e.g., floral diversity, density, and canopy cover), and avian indicators (diversity, abundance and endemism).

Secondly, this study tested the hypothesis that socioeconomic value of land may be higher in intermediate systems than monoculture systems. This is assessed by evaluating socio-economic indicators such as annual rate of income per unit land area and household consumption values for different land-use types.

The diversity gradient recorded for avian communities in the different land-use systems indicated that changes in vegetation structure had a strong influence on bird community structure. Diverse agro-ecosystems such as home gardens and tea mixed cultures supported a higher avian diversity with higher endemism and more rare species. Abundance of forest bird species was also higher in these diverse agro-ecosystems. Avian diversity was significantly lower in tea monoculture plantations. Although avian population densities were very low in the pine plantations, species diversity was relatively high in these plantations. However, most of the recordings from pine plantations occurred when birds crossed the system to use village habitats.

Intensive cash crop systems did not maintain satisfactory ground cover to protect soil and accelerate soil and nutrient loss from the land. Greater removal of production as tea leaves leads to more open nutrient cycles. As a result, these systems require greater amount of inorganic fertilizers as inputs to maintain production of the land, which in turn affects the biological processes that maintain these systems and can lead to their collapse. It was found that some of the monoculture systems became unproductive even with high fertilization.

The main source of income for local people in the region is from tea plantations. Income analysis per unit land area cultivated by different crops indicated that mixed crop tea plantations on small land holdings are the most productive compared to other land use systems if they are well managed. Land distribution is uneven in the region and limited land area is available for the majority of households trying to maximize their income through intensive tea monocultures. Large landowner systems like tea and rubber monoculture plantations (more than 2 ha) were not as productive as small landowner systems. Pine plantations did not provide any income or benefits to local people and created difficulties for paddy and tea cultivation due to the spread of pine roots into agricultural lands and the drying up of water sources. However, local people prefer intermediate and natural systems than intensive pine monoculture plantations due to their experiences with loss of resources (water, bee honey, medicinal plants and fire wood) in these pine monoculture systems compared to natural or intermediate systems.

Male labor is limited for agricultural activities in the study site due to their extensive participation in the *jem* (precious stones) mining industry in the area. They were able to make large profits during the last two decades through *jem* mining activities. Other potentially more profitable industries related to intermediate systems, such as honey and juggery production by taping *kitul* palm (*Carriyota urens),* declined due to lack of interest, knowledge and time. Available palm tree resources are use to produce toddy instead of honey and juggery to produce alcohol for workers engaged in the *jem* mining industry. Toddy production does not require more time or labor, and profits are quicker but lower compared to the other two industries. However, male labor in the KDU site is more abundant for agriculture and they obtain significant profits through intermediate systems. Honey and juggery production by taping *kitul* palm (*Carriyota urens)* in intermediate systems is one of the most profitable industries recorded from the KDU study site.

It is often argued that there exists a direct tradeoff between ecological sustainability and economic sustainability. However, this study demonstrated that this tradeoff may be overcome through well-managed, mixed-crop intermediate systems by allowing for a more positive relationship between ecological and economic sustainability as compared to mono-culture systems. Thus, it is important to develop greater knowledge and awareness of mixed production systems in order to obtain target incomes while maintaining ecological balance. Specific applications of the results of this study to future research on assessing the ecological and economic sustainability of intermediate production systems in Sri Lanka are discussed.

# SESSION 5 - BIODIVERSITY

# INTERMEDIATE AGROFOREST AND LATE FALLOW SYSTEMS AS OPTIMAL STRATEGIES FOR SUSTAINABLE MANAGEMENT OF BIODIVERSITY AND PROFITABILITY IN TROPICAL FORESTS

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In many tropical forested lands where capital is available, permanent, intensive cropping systems are more profitable in the short term than their less intensive counterparts. Comparative studies of land use impact on biodiversity and related agricultural productivity suggest that in the longer term, where intensive farming systems are isolated from natural ecosystems, there is likely to be progressive decline in environmental quality and, ultimately, profitability. Vegetation-based, biodiversity surveys using uniform methods were carried out in Sumatra, Thailand, Cameroon and Mexico along a series of land use and natural resource -gradients ranging from closed tropical forest through tree plantations, agro-forests and subsistence gardens to degraded grasslands. In each case biodiversity measured as richness in both vascular plant species and plant functional types was consistently higher in complex agro-forests and late fallow systems than in most other land use types including lowland rain forest. In Sumatra and Thailand, with the exception of intensive, fertilised cropping systems, biodiversity varied directly with soil fertility. A multi-taxa, biodiversity baseline study in lowland Sumatra showed consistent increases in species richness in faunal groups in complex agro-forests compared with those under other land uses including closed-canopy rainforests. In the Zona Maya of the Yucatan peninsula of Mexico, biodiversity in late-stage fallows exceeded that under intensive cropping systems and in adjoining, managed rain forest. In Central Sumatra, the impact of different land tenure systems on biodiversity indicates that biodiversity is higher in small-holder Oil Palm plantations than in those of equivalent size managed by large company estates. In South Sumatra biodiversity is higher in Coffee plantations with mixed crop species under shade than in simple, non-shaded systems. Overall, ‘intermediate’ agroforests may provide longer-term stability in both biodiversity and profitability than monocropping especially when managed within a landscape mosaic of different vegetation types including forest. Composition rather than richness of species and functional types is likely to provide a better indication of ecosystem performance. It is argued that generic biodiversity assessment methods using both plant species and plant functional types can provide rapid, quantitative and uniform comparison of impacts of farming systems within and between countries. This is potentially useful in seeking trade-offs between biodiversity and profitability particularly where comparative estimation of the latter varies with cultural and socio-economic background.

## BENZOIN GARDENS AND DIVERSITY IN NORTH SUMATRA, INDONESIA

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*Keywords:* benzoin gardens; traditional management systems; tree diversity.

In recent years tropical forest conservation debates have focused increasingly on traditional management systems. Some believe these systems may provide the means to meet both conservation and development goals in tropical rural areas. The study of benzoin gardens contributes to this debate by assessing the impact of this management regime at the ecosystem level, in terms of forest structure, tree species composition and diversity. Two villages were selected in the benzoin cultivation area of the North Sumatra highlands; 45 gardens were sampled in randomly distributed plots. For each garden data on establishment, management practices and productivity were collected in interviews with the garden owners. Ecological information was gathered in gardens, in secondary forest areas developing from gardens abandoned for over 30 years, and in primary forest areas. The results show that benzoin gardens represent a low-intensity disturbance of the ecosystem, maintaining a structure that allows effective accumulation of forest species.

Garden management, mainly by non-selective elimination of vegetation with a machete, allows species with a vegetative reproduction capacity to remain in the garden and reduce the effects of competitive exclusion mechanisms on species composition. Once the gardens are abandoned, tree diversity of the resultant secondary forest is similar to that in primary forest, which suggests a high resilience of this forest formation under current benzoin management practices. However, a more detailed look at vegetation composition indicates that, in primary forest, the species have a more restricted distribution and those that are characteristic of undisturbed environments occur in a higher proportion.

# THE BIODIVERSITY VALUE OF 'INTERMEDIATE SYSTEMS' OF FOREST MANAGEMENT AS AN ALTERNATIVE TO LOGGED FORESTS AND PLANTATIONS: BIRDS IN THE TRADITIONAL AGROFORESTS OF THE SUMATRAN LOWLANDS

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*Keywords:* Forest management; Agro-forest; Bird; Plantation

The composition and structure of the bird community was investigated in traditionally managed rubber tree *Hevea brasiliensis* agroforest in central Sumatra. Comparisons were made with undisturbed primary forest, two areas of logged natural forest, and exotic plantations of rubber and oil palm *Elaeis guineensis*.

The richness of bird species in the agroforest was 94% that of primary forest but the organization of the bird community had altered, with a smaller proportion of the species being locally rare. Also feeding guilds changed, with an overall increase in generalists and species of least conservation concern. Compared with the logged forest areas, there were 12-24% fewer mature forest species in agroforest and fewer species with narrow habitat requirements or a limited global range. Compared with the plantations of rubber and oil palm, agroforest had 50% and 69% higher species richness respectively and did not lack particular feeding guilds.

The bird feeding guilds showed five major types of response. The first group decreased in abundance with logging, agroforest and plantation development. These were the large species eating insects and fruits on the forest floor (pheasants) and the specialized insect-eaters of the mid-canopy and understorey. The second group was not negatively affected by logging, but decreased with agroforest and plantation development. These were the bark-gleaning insect-eaters (woodpeckers). The third group increased with logging and agroforest development but decreased in plantations. These were the middle story insect and fruit eaters, and the species eating nectar, fruits and insects of flowering trees and epiphytes. The fourth group did not change significantly with logging but increased with agroforest and plantation development. These were the grass-seed eaters and the scrub/open land generalists. The fifth group increased with all the disturbance. These were the small species eating insects on the ground.

Traditionally managed agroforest has lower biodiversity value than logged forest, but it is significantly more valuable than exotic plantations. Their wildlife is an important source of meat and income, particularly for poorer families during times of stress. Agroforests become even more valuable to biodiversity if large trees and understorey microhabitat structure are left untouched and hunting is regulated. These measures could be encouraged by disseminating information to extension staff, discussing and reaching

agreements with priority villages (e.g., on establishment of a system of closed season, quotas or zones for hunting), and encouraging districts to issue supporting by-laws.

In terms of biodiversity conservation, intermediate forest systems are an attractive alternative to exotic plantations. Intermediate forest systems may be one of the best compromises between conservation and economic development, even if they do not match either the short-term economic returns provided by exotic plantations or the biodiversity levels of primary and logged forest areas.

Investments and policy interventions are urgently needed to protect and expand intermediate forest systems instead of monocrop production (but not as a substitute for primary or sustainable natural forest management) in order to curb the degradation of ecosystems and the extinction of species. From a conservation perspective, intermediate forest systems are a particularly valuable substitute for monocrops in and adjacent to key sites for conservation, in buffer zones and other sites adjacent to protected areas, in corridors providing connectivity of forest canopy between large blocks of forest, and in continental regions (rather than oceanic islands) with many wildlife species that require large home ranges.

# EVOLUTION AND SUSTAINABILITY OF INTERMEDIATE SYSTEMS: TREE INTEGRATION IN HOMESTEAD FARMS IN SOUTHEAST NIGERIA

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*Keywords:* Tree integration, homestead farms, rural livelihood strategies, intermediate systems, Nigeria

This paper contributes to wider debates on the dominant factors determining the emergence and sustainability of intermediate systems of forest management in developing countries. The theoretical framework for analyzing the evolution and sustainability of tree integration in homestead farms is presented, with three propositions with reference to southeast Nigeria. First, at the household level, livelihood strategies constitute the main determinant of the decision to integrate trees in homestead farms. Second, induced innovation has a wider and significant role at the community level than at the household level in encouraging the integration of trees in farms. Third, the sustainability of observed patterns of tree integration is influenced by the interaction of environmental, ecological, political, economic and social factors. Based on these propositions and using research evidence from two states in southeast Nigeria (i.e. Cross River and Akwa Ibom), the paper analyses the internal (household) and external (wider community) factors influencing tree integration in homestead farms.

The empirical evidence from southeast Nigeria provides support to three of the hypothesis for this workshop, regarding the factors driving the emergence and evolution of intermediate systems. First, the development of markets for non-timber forest products is a major determinant in the emergence of intermediate systems. This is clear from the studies in Akwa Ibom and Cross River States where households are increasingly incorporating trees in homestead farms. Second, increased land scarcity is a major driving force behind the evolution from "intermediate" systems to more intensive production. This is more relevant to and evident in Akwa Ibom State, with an average population density of 326 persons per square kilometer. Third, farmers have used "intermediate" systems as an appropriation strategy especially where external actors questioned the traditional forms of forest resource control and ownership. A good example in this regard is from Cross River State, where farmers lost access to forest resources within the area constituting the Cross River National Park. The paper concludes by suggesting that at the household level, livelihood strategies constitute the main determinant of households' decision to integrate trees in their farms. However, there is no doubt that induced innovation has a wider and significant role at the community level than at the household level in encouraging the integration of trees in homestead farms. Overall, households' adaptation to the dynamic changes in economic, environmental and

social conditions constitutes the dominant factors leading to the emergence of tree integration in homestead farms.

# THE MAYAN HOME GARDENS OF YUCATAN, INTERMEDIATE OR ALTERNATIVE SYSTEMS?

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Two land-management systems based on opposite economic conceptions of resource use have co-existed in the Yucatan Peninsula since the arrival of the Spanish conquerors and they have given rise to different agro-systems. Under the term "modern systems" we can group those focused on commercial production that were established by the Spanish and later promoted following the Mexican independence. On the contrary, "traditional systems" would be those aimed at a subsistence economy which are the main elements of the Mayan productive strategy: the slash-and-burn itinerant maize (or maize-squash-beans) cropping, the home garden and the selective extraction of different products from the natural forest remnants.

At present, most "modern" systems have disappeared due to economic and environmental reasons, leaving behind a short-term economic wealth and a long-term ecological impact. The shallow rocky soils of the area, which precluded any technification, and competition with alternative products drove them to bankruptcy, while the degradation of natural forests in Northern Yucatan evidences their environmental unsustainability. However, traditional systems have survived until today allowing for the economic subsistence (though precarious) of Mayan families and for the conservation of ecological values.

The origins of Mayan home gardens of Northern Yucatan are rooted in the ancient knowledge about the management of semi-natural forests in the humid Southern Yucatan. There, intensive forest management systems aimed at horticultural production have been described as being widely distributed before the Spanish conquest. Thus, by the XVIth Century there were already home gardens in the area, though with a different structure to the present one. At that time, the indigenous peasants cultivated many neotropical species and had applied domestication processes to many other species brought from the semi-deciduous and evergreen southern forests. Since the conquest up to the present, the Mayan peasant has progressed further towards the incorporation of new species to the home garden, mainly citruses (*Citrus* spp.), banana (*Musa* spp.), tamarind (*Tamarindus indica*) and mango (*Mangifera indica*).

The present home garden is a very diverse and finely managed system. The study of 300 Mayan home gardens from 15 villages in the five economic zones of Northern Yucatan has shown: (i) the high tree and shrub diversity of home gardens, with a total of 156 species (21,5 ± 0,4 by garden); (ii) the relevance of autochthonous plants in terms of species (75% from the Yucatan Peninsula *vs.* 6% from the Neotropics and 19% from the Old World) and individuals (48%, 13%, and 39% respectively); and (iii) the preponderance of cultivated plants (64%). It has also been found that the home garden is rather resistant against changes in the economic situation, with minimum tendencies towards specialization-intensification or abandonment. In general terms, the home garden is a productive unit devoted to the provision of goods for the family use, and it is maintained irrespective of the economic activity of the rural family. The minimum inputs necessary for their maintenance, its value as a sure resource during normal and slack periods, and the self-sufficiency economy of most Mayan families undoubtedly play a role in this direction.

As a result, the Mayan home garden has proven to be a rather stable system based on the indigenous wisdom on the management possibilities of the environment, and on his attitude towards including new species in the system. On the one hand, although natural conditions are very restrictive in the area, the indigenous peasants have built up and still maintain a system that harbors up to a 47% of species (and 73% individuals) with ecophysiological traits suited for diverse habitats. In this sense, the Mayan villages are islands of medium-tall semideciduous forest within a landscape of low deciduous forest characterized by a 6-8 month drought, a total lack of running waters and shallow rocky soils. On the other hand, the high species diversity reached by the combination of species with very different geographical origins leads to the year-round production of goods, and the management assures a high inter-annual stability of production. Moreover, the inclusion of domestic animals and some tree species acts as a savings account, since they are products easily transformed into cash whenever a monetary need comes up.

The Mayan home garden is thus a traditional but not static agro-system, and it is in fact a fine example of a man-made system dating to pre-hispanic times. The environmental adversity of Northern Yucatan has thus precluded the perpetuation of any form of specialized "modern" agriculture among those introduced into the area, and the Mayan home garden is by no means a byproduct of them. Therefore, the home garden should be considered an alternative system with ancient roots better than one intermediate step in the transition between ancient and modern agro-systems. Any improvement proposed for them, be they focused towards management, productive, marketing or environmental issues, should be based on this perspective, and should be derived from cooperative work between technicians and indigenous peasants.

# TREE-CROP INTEGRATION IN FARMLAND, THEIR IMPACT ON SOIL FERTILITY AND FARM INCOME AND INFLUENCING FACTORS FOR ADOPTION UNDER THE SUBSISTENCE FARMING SYSTEMS OF THE MIDDLE HILLS, NEPAL

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Hill farming in Nepal is heavily dependent on forest resources. Forest and grazing lands have been continuously undergoing degradation due to heavy extraction of fodder, fuelwood and other forest products especially in the vicinity of the settlements. The current extraction rate far exceeds sustainable supply from the forests. Population growth combined with diminution in landholdings owing to continuous land fragmentation, large livestock herd size, deforestation and subsequent resource depletion has put enormous pressure on farmland and hardship to the subsistence farming communities. There is growing evidence that planting and protection of assorted trees and shrubs in farmland as intermediate systems between forest extraction and plantation forestry can provide potential solutions to meeting the subsistence needs and reducing resource degradation. Intermediate systems that minimize the rate of resource degradation, provide the substitutes for forest products, improve soil fertility, increase crop yields and raise farm income are key to sustaining the agricultural productivity in the hills. In these contexts, the objectives of this paper were to 1) investigate the prospect of incorporating tree species into farmlands, 2) examine its impact on soil fertility and farm income and 3) identify factors influencing its adoption by subsistence farm households in the hills. This paper is part of a comprehensive Ph.D. research based on a sample of 223 households survey (82 “with” and 141 “without” project) from Kumpur, Nalang, and Salang of Dhading district, Nepal and conducted during April to October 1998. The project was implemented in 1993/94 by the Nepal Agroforestry Foundation, an NGO involved in promoting agroforestry. Soil samples were analyzed to examine the impact on soil nutrients. The analysis showed greater potential to incorporate trees in cultivated land, improve soil fertility and raise farm income.

The results revealed that these intermediate systems made a positive contribution to soil fertility. Among the species found in farmland the fodder trees dominated, which is linked to farmer’s orientation towards self-sufficiency. The benefit-cost analysis showed that the improved system with introduced trees was more profitable than the conventional system. The results also showed that the introduction of multipurpose trees, such as mulberry (*Morus alba*) for sericulture, could further enhance the profitability of the system. Farmers’ decisions to start sericulture using mulberry leaves indicated a trend towards their integration into the market economy. Similarly, multiple factors influenced the adoption decisions. The slower adoption showed some resistance against economic

changes owing largely to technical and socio-economic constraints. According to the logistic regression analysis, livestock population, female education, male’s NGO membership, and farmer's positive perception had significantly positive effects, while the male education, female's NGO membership, and respondents’ age had significantly negative effects on adoption by project households. For non-project household, those having more livestock and greater male membership to local NGO were more likely to adopt, while households headed by males were less likely to adopt the practice. Thus, with increased investment and policy interventions, tree-based farming under intermediate forest management systems has great potential for enhancing farmers’ economic conditions through its positive contributions to conservation, soil fertility and household income in the hills.