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SUMMARY

Rural forest managers in tropical countries have used and traded forest products as long as historical annals recorded this. They also conserved forest for the sake of sustaining the supply of these forest products. These realities have drawn the attention to forest commodities among development and conservation practitioners. It was expected that increasing forest product trade could increase the income of the rural poor living in or close to tropical forests. The international tropical forest conservation movement, in turn, foresaw that commercialisation of forest products could contribute to conserving tropical forests.

This volume critically investigates the proposition that commercialisation of forest products contributes to both enhancing people's income and to conservation of tropical forests, using evidence from a case study from West Kalimantan, Indonesia. The volume draws the main conclusion that promoting commercialisation of forest products often leads to a shift of the dominance of this trade by outside entrepreneurs. Even where local people manage to control the trade, the conservation impact on tropical forests is only indirect. By studying detailed examples of local forest management in three indigenous villages in West Kalimantan, Indonesia, the volume concludes that the conservation of tropical forests through forest products commercialisation is most likely to happen when local producers shift to active management of forest products in anthropogenic forests. The long-term impact of such local forest management depends importantly on how local or regional economies develop. Land use intensification may take place on some parts in the landscape, whereas previously intensively managed forests may be left to themselves.

Seven chapters that discuss different aspects of forest product trade and forest management in West Kalimantan support these conclusions. Indigenous swidden agriculturists in Kalimantan usually incorporate forest management in their portfolio of economic activities. This type of land-use, however, is closely integrated with the swidden agriculture cycle as it competes for land and labour. Management of swidden fallow secondary forests may include conversion towards extensive tree crop production when there is the threat that fallow land may turn into *Imperata* grasslands. Conversion of swidden fallow land into extensively managed rubber gardens may lead to an effective increase of land under forests. Specific forest management practices, like protection and tending of trees in which honey bees nest, can be used in reforestation efforts. Some of these types of managed forests maintain a complex structure and species diversity that is sufficiently high to consider their contribution to conservation.

RINGKASAN

HASIL HUTAN DAN PENGOLOLAN HUTAN LOKAL DI KALIMANTAN BARAT, INDONESIA: IMPLIKASI UNTUK KONSERVASI DAN PEMBANGUNAN

Para pengelola hutan di negara-negara tropis sudah memanfaatkan dan melakukan perdagangan berbagai jenis hasil hutan sejak lama sekali ketika sejarah mulai mencatat kegiatan ini. Mereka ini juga melestarikan hutan supaya berbagai hasil hutan yang berasal dari dalamnya dapat diambil terus-menerus. Kenyataan ini telah menarik perhatian terhadap komoditas hasil hutan di kalangan para praktisi pembangunan konservasi. Peningkatan perdagangan hasil hutan diharapkan dapat memperbaiki pendapatan masyarakat pedesaan yang tinggal di dalam atau di sekitar hutan tropis. Kalangan internasional dalam gerakan konservasi hutan tropis juga melihat bahwa komersialisasi berbagai jenis hasil hutan berpotensi untuk memberikan sumbangan bagi konservasi hutan tropis.

Publikasi ini berusaha melakukan investigasi secara kritis mengenai pandangan bahwa komersialisasi berbagai jenis hasil hutan berpotensi meningkatkan pendapatan bagi masyarakat dan juga bagi konservasi hutan tropis, dengan menggunakan bukti-bukti dari suatu studi kasus di Kalimantan Barat, Indonesia. Tulisan ini menyimpulkan bahwa promosi komersialisasi berbagai jenis hasil hutan sering menyebabkan perdagangan ini menjadi lebih didominasi oleh kalangan pengusaha dari luar. Bahkan ketika penduduk lokal sanggup mengontrol perdagangan ini, dampaknya bagi konservasi hutan tropis hanya bersifat tidak langsung. Dengan mempelajari contoh-contoh pengelolaan hutan oleh penduduk lokal secara mendetail di tiga desa di Kalimantan Barat, Indonesia, dapat disimpulkan bahwa konservasi hutan tropis melalui komersialisasi berbagai jenis hasil hutan kemungkinan besar hanya terjadi ketika para produsen lokal terlibat aktif dalam pengelolaan berbagai hasil hutan di hutan-hutan yang dikelola manusia. Dampak jangka panjang dari pengelolaan hutan secara lokal ini sangat bergantung pada bagaimana perekonomian lokal dan regional berkembang. Intensifikasi pemanfaatan lahan mungkin terjadi di sebagian dari lanskap, sementara hutan yang sebelumnya dikelola secara intensif mungkin akan dibiarkan saja.

Tujuh bab dalam buku yang menguraikan berbagai aspek yang berbeda dari perdagangan hasil hutan dan pengelolaan hutan di Kalimantan Barat ini mendukung kesimpulan di atas. Para peladang berpindah asli di Kalimantan umumnya juga melakukan kegiatan pengelolaan hutan dalam portfolio kegiatan perekonomian mereka. Namun jenis pemanfaatan lahan seperti ini terkait erat dengan rotasi dalam sistem peladangan berpindah karena kedua kegiatan ini (pengelolaan hutan dan berladang) saling bersaing dalam hal lahan dan tenaga yang diperlukan. Pengelolaan hutan sekunder yang sedang diberakan mungkin juga dilakukan dengan melakukan konversi untuk penanaman tanaman perdagangan, khususnya jika ada potensi ancaman bahwa lahan bera ini akan beralih menjadi lahan alang-alang (*Imperata*). Konversi lahan yang sedang diberakan menjadi kebun karet yang dikelola secara intensif mungkin akan meningkatkan luas lahan yang ditumbuhi hutan. Praktik-

praktik pengelolaan hutan secara khusus, seperti perlindungan dan pemeliharaan pohon-pohon yang digunakan sebagai tempat bersarang lebah, dapat dimanfaatkan dalam upaya penghutanan kembali. Bentuk-bentuk pengelolaan hutan seperti ini mempertahankan struktur hutan yang kompleks dan keragaman jenis yang cukup tinggi sehingga dapat memberikan sumbangan bagi usaha konservasi.

CHAPTER 1
A REVISION OF THE CONSERVATION *THROUGH COMMERCIALISATION* PROPOSITION

1. INTRODUCTION

In the environment-development related debates the economic and cultural importance of forests for local forest dwellers, and the related stewardship that these dwellers extend to these forests have received wide interest. Two general assumptions are the basis for this interest:

- On the one hand, there is a widely held recognition of the importance of natural resources among many rural dwellers worldwide. There is much worry, and maybe less evidence, that the widespread advance of logging and agricultural “frontiers” and the effect they have on the conditions of forests, negatively affect the well being of people dependent on those resources.
- Closely related to this is the assumption of the validity of one strategy to reduce the decline of natural resources: to give them in stewardship to the communities that do depend on these forests. Their interests in maintaining benefits from these resources is supposed to be an important incentive to better take care of the natural resources, at a lower cost to society at large.

Related to these two propositions is the discussion on forest products (FP)[1]. Forest products are natural products from forests that are used by people living in or near the forest, or even by people living outside forest areas. They include plants, animals, or other life-forms, or particular parts of any of those. FP have attracted documented scientific interest since European countries colonised tropical regions. This interest was one more time boosted when the paradigm of sustainable development appeared on international agendas, as it was expected that rural incomes could be improved through commercialisation of what where then called *minor forest products*. Since the 1980s the hope was put on FP to contribute to the conservation of tropical forests. Harvesting FP from these forests, the argument went, could become an alternative to the use of forests for logging or conversion to agriculture.

The widely held assumption that FP production[2] and trade can lead to improving rural poor’s monetary incomes is, however, not without its problems. Neuman and

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[1] We mean with forest products what mostly has been referred to as non-timber forest products. We exclude all industrial forest product exploitation, or capital intensive, large-scale plantation, but rather refer to those products that are collected, used or otherwise produced by small holders.

[2] With production of FP we mean collection from the wild, but also a set of related cultural activities like protecting and claiming property rights of wild stocks, tending of wild stands, or reproduction of FP species in extensively managed anthropogenic forests.

Hirsch (2000) suggest a wide range of constraints that inhibit a straightforward relationship between increasing sales of forests products and increasing incomes among producers. Some of these are existing market structures, variable costs to procure FP in relation to the amounts harvested, and others. The opportunity to actually increase income from FP production and trade is, therefore, not easily to be assessed.

Similarly, the proposition that commercialisation of FP will boost conservation of forests has been questioned. This proposition is referred to here as the "conservation through commercialisation proposition". Successful commercial Brazil nut extraction in the south of Para, Brazil, did not prevent gold mining or cattle ranching to become the main economic activity in the region leading to widespread deforestation (Schmink & Woods 1992). Several authors (e.g. Wiersum 1997; Homma 1992, 1996; de Jong 1999) predict that successful commercialisation of FP will lead to changes in the production of FP; changes that do have its impact on the forests from which these products were initially harvested.

This volume reports the findings of the research on forest management among swidden agriculturists in the province of West Kalimantan, Indonesia, a research that critically assesses the validity of the two assumptions explained above. This chapter will critically re-think the proposition, that commercialisation of FP can actually lead to sustained development and conservation of tropical forests. The chapter will first summarise the role of FP in people's economies and its contributions to national economies, as reported in the literature. It will briefly discuss some of the theoretical propositions that have been formulated related to FP commercialisation. The chapter will then critically rethink the propositions with the evidence from the case studies reported in the subsequent chapters. Finally, the chapter proposes a reformulation of the FP conservation through commercialisation proposition.

2. THE ROLE OF FP IN HOUSEHOLD AND NATIONAL ECONOMIES

2.1 The contribution of FP to people's livelihoods

The importance of FP in rural people's livelihoods has been reiterated in various occasions (e.g. Falconer 1996; Melnyk 1996; Arnold and Ruiz-Perez 1998; Neuman and Hirsch 2000). People produce FP for daily consumption and as traded items, and this contributes significantly to rural incomes. Often FP have a specialized, complementary role in household economies, for instance when other resources fail, in between harvests, or in times of bad harvests. De Beer and McDermott (1997) and others provide many examples of FP as emergency food. Moreover, forest foods and products are often particularly important for poorer groups within the community. Cavendish (1997) for instance, showed that although within the lowest 20% income group_incomes from FP had a significantly higher percentage contribution to its income, the total volume of consumption was smaller than among the highest 20% income group. These findings have important implications when considering measures that result in changes of supply or distribution of FP within communities.

The important role of FP in rural people's livelihoods is not accidental. Neuman and Hirsch (2000) give three main reasons why FP production is an economic strategy that especially the poorest will recur to:

- FP production requires little capital investment,
- Tropical forests, which are the most important suppliers of FP, are often occupied by the poorest segments of societies, and
- In most cases those forest dwellers have no alternative sources to obtain income.

As a result, the literature suggests similar FP related income patterns over widespread and varied areas throughout tropical regions (Neuman and Hirsch 2000). FP may be critical to overall subsistence and can supply a high percentage of household cash income. Households may rely on FP incomes when other income is low, although this, as a rule, does not mean that income is evenly distributed among single communities of FP producers.

2.2 Benefits of FP to non-collectors

Not only are FP collected and sold, they also occupy considerable amount of people in downstream industries. An important part of the rural population in South East Asia earn income and find employment through forest-based small-scale enterprises, while the greater part of these depend on FP for their raw material. These industries are some of the main markets for forest product collectors in rural areas. Many farmers increase their incomes from transformation of FP often during periods with little other work demands or income opportunities. However, at present processing industries for FP in South East Asia countries are still in an embryonic stage, meaning that total aggregated income from FP procurement and transformation is still sub-optimal. Without specific policy changes and programs to encourage them, it is unlikely that they will develop further (de Beer and McDermott 1997). Recent findings have also shown the important participation of urban based collectors in FP based economies (e.g. Stoian 2001).

Benefits of FP not only accrue to the collectors, but also to many small intermediary traders. This category of FP dependent people is often, and sometimes incorrectly, looked upon as those who abuse of collectors efforts, and obtain the largest part of the benefits from the FP economic exchange. Several authors (e.g. Padoch 1992) have demonstrated this to be an incorrect representation of reality. Many small-scale intermediaries have few resource and modest benefits, while carrying relatively high risks. In many proposed development schemes these small traders are the last ones considered, and often threatened with being pushed out of their business.

The several regional overviews produced the last decade (e.g. de Beer and McDermott 1997; Broekhoven 1996; Falconer *et al.* 1990; Neuman and Hirsch

2000) demonstrate that aggregated FP trade constitutes an important economic sector in national or regional economies. For instance, the total volume of FP export in Indonesia reached a value of US$ 238 million in 1987 (de Beer and McDermott 1997). That year the rattan products export was valued at US$ 143 million. In addition about half a million people were engaged in collecting, processing and trade in SE Asia while close to 150,000 people worked in the rattan processing industries (de Beer and McDermott 1997). The export of rattan has declined dramatically since then (e.g. Belcher *et al*. 2000). Rattan is, however, but one of six other FP traded in large volumes internationally that originate from South East Asia. Others are edible-oil baring nuts, *gaharu* incense wood, edible bird nests, honey and wax, meat and fish, and gums and resins (de Beer and McDermott 1997). The Brazil nut market, one of the principal FP from South America, has a US$ 30 million worldwide market (Stoian and Henkemans 2000; Bojanic 2001).

FP have been collected from South East Asia since thousands of years (Peluso 1983), and before timber took over they constituted the most important category of forest resources. Many forest products that are currently internationally important, became widely demanded only in recent decades. For example, rattan boomed between 1968 and 1977. Although the export from Indonesia has now collapsed, international demand for rattan remains high (Belcher *et al.* 2000). Dipterocarp oleo resins and *gaharu* also increased dramatically during the late 1970s, early 1980s, but their markets are fairly stable. Markets for newer products are escalating. This is true for natural products in general, and health food ingredients in particular. Other products are coming back, e.g. jelutong which is now used in dentistry and for making pencil points. Phyto- medicine markets are expanding, i.e. in Europe and US, but also in emerging markets like China, South Korea, and Taiwan. Many other products, however, are loosing ground, and so are its producers (de Beer and McDermott 1997).

3. THE UNANSWERED QUESTIONS RELATED TO FP COMMERCIALISATION

The interest for FP has increased since the 1980s because of the supposed development potential that FP hold, and because of the conservation spin-off effect that supposedly can be achieved when commercialisation of FP becomes successful. The conservation –through-commercialisation-proposition became part of much of the conservation agendas, and lead to many initiatives that aimed for FP commercialisation as strategies to achieve forest conservation. However, since the late 1980s this proposition was questioned based on a number of reasons. First, it has been questioned to what extent commercialisation of FP can improve income of the primary collectors. One recurrent problem observed by Dove (1993a) and Neuman and Hirsch (2000) is that increased profits do not end up with the primary producers. Second, the issue of sustainable supply of FP is not easily answered.

Homma (1996) predicts that extractive economies will necessarily evolve towards plantation production, a proposition that according to Neuman and Hirsch (2000) needs revision. This section will address these points in somewhat more detail and compare them with the evidence from the studies in Kalimantan presented in subsequent chapters.

3.1 Can FP development improve people's livelihoods?

One body of literature that describes the changing fate of successful commercial forest product harvesting, and that questions the validity of forest conservation through FP development, focuses on the changes in resources control and ownership in relation to the changing economic importance of these resources. Especially Dove (1993a, 1994) brought this issue to the forefront of international discussion, questioning the validity of FP development and its subsequent conservation potential. Basing himself on examples from Indonesia he argued that powerful entrepreneurs control the more attractive forest resources. These entrepreneurs focus on timber, but also on other FP for which important markets developed, and from which they accrue the largest portion of the profit. Those FP that are left to the control of the poor, are those that are economically much less attractive. According to Dove, it is likely that the largest parts of the benefits of the exploitation of any newly to be developed forest product will eventually also fall in the hands of such larger merchandisers, and not in the hands of the poor forest farmers. Neuman and Hirsch (2000) hold that even in situations of expanding markets and increasing prices, the economic situations of primary collectors do not change. On the other hand, exploitative relationships appear to be most evident in cases where intermediaries or middlemen are the primary point of sale for producers. Traders are then able to cooperate to both fix prices and control "delinquent" collectors. Where competition between traders is more severe, or where primary producers have options to turn to alternative channels to sell their products, opportunities for collusion are much less (e.g Padoch 1992).

The literature review in Chapter Three suggests that in general Dove's assessment of the political economy related to commercialised FP is likely to happen, at least at an initial stage. The many examples of commercialised FP and the responses of the several actors who manage to get hold of a share of the profits do not bode well for any initiative that aims to increase FP trade. However, the evidence from Kalimantan also suggests that the actors that become involved in FP production and trade vary per product, and vary during the course of history. In addition, the nature of their action also varies and changes over time. Chapter Three discusses rent seeking in FP trade in Borneo and surrounding regions over several hundreds of years, while for the sake of FP development purposes the time-span of interest is much smaller.

It is, however, important to point out that the political economic conditions in places vary. Especially in relation to control over forests, in many countries in the world some form of communal forest management is pursued. This does not exclude the possibility that some of the other, non-local actors involved in future FP production and trade will pursue rent seeking activities, be they trader, state officials, or others. These activities are more worrisome in conditions of bad governance, as Chapter Three suggests. It is, however, likely that the nature of these actions changes as a result of changes in the general political climate, something that is now increasingly happening with world-wide trends of decentralised government. Although this is not likely to solve problems of rent seeking in FP trade, it will most certainly change the way that happens.

3.2 The evolution of extractive economies

The options to enhance people's incomes through FP development are also questioned purely on economic reasons. Wilkie and Godoy (1996) propose a model of the changing role of FP in the economies of forest farmers. When little commercial contact with outsiders exists, many FP are collected but few are traded. Commercial use of FP is driven by cash demands from poor households (Neuman and Hirsch 2000) and once trade opportunities are known, more time will be devoted to collecting marketable FP. The opportunity costs of labour increase, as do monetary incomes of households. Eventually consumption of non-tradable FP will decline as households will acquire substitutes rather than invest in the procurement of these products. Neuman and Hirsch (2000) from their literature study indeed observe a perfect inverse relation between dependence on FP and total household income. As the opportunity cost of labour rises, forest use will increasingly concentrate just on higher value outputs (Arnold and Ruiz Perez 1998). Further changes include establishment of clearer property rights and efforts to start to enhance production of the traded FP.

These arguments suggest that there is an economic evolution towards higher material living standards in which FP may play an important role. However, several difficulties remain prominent when considering FP commercialisation as a way to increase rural incomes. Demand for FP is one of the main impediments to the development and maintenance of an extractive system. Demand curves for FP may be highly inelastic and increased supply at lower prices will not automatically lead to an increased demand by consumers. Even though there is sufficient evidence that incomes from collection are equivalent to other income sources in regions where conducted, this still does not solve the problem of structural income inequalities (Neuman and Hirsch 2000). FP appear critical in the subsistence of the rural poor, and often have a strong income equalising effect between poor and wealthier classes (Cavendish 1997), but they rarely provide the means for the poor to actually move up to the wealthier classes and achieve socio-economic advancement. Ultimately, it appears that commercial exploitation of FP contributes little to address the structural origins of poverty (Neuman and Hirsch 2000).

Homma (1996) presents one of the most articulated theories on the evolution of extractive economies, which largely foresees a rather narrow evolution of extractive economies. In Homma's view, when new FP start to attract outside demand, extraction and trade will expand. When the product is in full boom, extractors will attempt to maintain extraction levels to meet demands, even at increasing production costs. Ultimately, however, increasing prices will lead to economic exhaustion of the resource, such that their procurement is not feasible anymore. By this time the boom has collapsed and the FP resource has severely declined, although as a rule biological extinction does not occur. In some, but not in all cases, successful production will have been attempted in plantations, or through the manufacturing of substitutes.

The model proposed by Homma, is not without its problems. Neuman and Hirsch (2000) suggest that Homma's model assumes steep supply curves and that their shape is more important in determining dynamics than the shape of demand curves. These assumptions do not always hold true, as mentioned above**:** demand curves for FP are often quite inelastic. Even in cases where those assumptions hold true, there still remains considerable variability. Several factors, like labour requirements for alternative forms of production, land ownership, farm size, production costs, and lack of knowledge are factors that may inhibit domestication of the FP. Often, rather than turning to planting FP, collectors may shift the regions of procurement. Coomes (1995), Potter (1997) and Stoian (2000) suggest that regional economies may rely on a changing suite of collected FP, subsequently shifting from one to another product. Products may be over-harvested until the supply becomes too low to maintain markets. But eventually, if stocks are restored, the same products may attract wider demand again. Similar patterns may happen the other way around. Even where FP has moved through the substitution/ domestication phase, the future demand for the extracted product is not completely predictable, and may decline (Neuman and Hirsch 2000).

The cases reported from Kalimantan in this volume provide an ambiguous picture of the changes when FP commercialisation occurs, or when market oriented production plays an increasing role in places where people subsisted on agriculture and forest production. In general, FP producers respond less directly in their overall subsistence strategy than is suggested. Dove (1993b) holds that among the Kantu in remote parts of West Kalimantan, Indonesia relied little on commercial rubber production for a long time. Rubber became easily incorporated as part of the swidden fallow management without too much change in the overall economic strategies (Chapter Six). Farmers only turned to tapping when they had immediate cash needs. They did not consider serious change in any of their other economic activities. Chapters Three and Four show that farmers who have experienced longer and more intense participation in market economies most certainly have adopted more commercial activities. However, as Chapter Four suggests, forest product collection still plays an important role in family activities, to an extent that people will maintain a suite of activities related to FP procurement for a long time, even though returns from these activities are declining. Probably there is an important cultural reason for maintaining activities like hunting (Chapter Four) and honey procurement (Chapter Eight).

The results presented in subsequent chapters show a different change that contradicts trends suggested by Arnold and Ruiz-Perez (1998). Rather than diminishing investment in FP that are not commercialised, there is evidence that declining supply from natural forests is compensated with an increase in production of these products in managed forests. This is a phenomenon observed among other swidden farmers, for instance in Peru (e.g. de Jong 1995a). Rather than abandoning FP collection, farmers will continue to expend efforts to still supply the same kind of FP that cannot easily be found in near natural forests, even when those products are not sold. There may, however, be a cost effectiveness in such acting, as farmers may try to reduce time expended for spotting these product through producing them in their own forest gardens (de Jong 1995a).

3.3 The transformation of indigenous forest management

Wiersum (1997) defines forest management as the process of making and implementing decisions about the use and maintenance of forest resources and the organization of the related activities. Considering the broad definitions of forests, commonly used, forest management applies to a wide range of vegetation types that have trees as the main component. It includes natural forests, but also many types of tree based vegetations that are the result of different degrees of human interventions. Management of such kinds of forests occurs widely among many small farmers in tropical regions.

After analysing many indigenous forest practices, Wiersum (1997) distinguishes three categories of forest management, i.e. conscribed utilisation of forest products, active tending of forest stands, and regeneration of forest stands. Especially the latter two categories are not easily to be distinguished as many indigenous managed forests combine spontaneous and planted components. The many types of indigenous forest management can be located on a gradient that reflects a nature – culture continuum (Wiersum 1997). The assessment that this also reflects an increased input of human energy per unit of exploited forest needs critical revision. For instance, young swidden-fallow agroforests, that as a rule consist of a large spontaneous component, may receive more labour input than full-grown agroforests that have much less non-planted tree-species (de Jong 1997). In general, however, types of indigenous managed forests farther along the continuum, but in similar environments, will likely have a higher productivity per unit of land, at the expense of a lower species diversity, lower environmental regulation capacity and lower carbon stock (e.g. de Jong *et al.* 2001).

Some of the changes observed in Kalimantan confirm the continuum proposed by Wiersum (1997). As mentioned in the previous section, and as suggested in Chapter Five and Chapter Six, participation in wider market economies and land pressure lead to a transformation of forest management. The sequence of changes, however, is complex. Groups throughout Indonesia have practiced different kinds of management of forest gardens. In places like Sumatra, early examples of intensification of management of forest garden seem to repeat itself in West Kalimantan. In Sumatra marketing of damar led to intensification of forest gardens which became dominated by *Shorea javanica*. There is evidence of intensification of forest garden management along similar trends as observed in Sumatra (e.g Chapter Three and Four). In villages with better road connections forest gardens are gradually transformed into stands dominated by *Durio zibethinus* gardens that are more intensively slash-weeded than forest gardens in more remote villages.

There is, however, little evidence from Kalimantan that some of the local species will be planted in mono-specific stands, as predicted by Wiersum (1997) and Homma (1996). In fact, even rubber that was brought over from South America and planted by the British in Malaysia and the Dutch in Sumatra early 20th century, became incorporated into local swidden fallow management (see Chapter Six). The concept of mono-specific production appears even in the case of rubber to be introduced by state extension agencies, rather than a spontaneous endogenous evolution. This on the one hand put questions on the proposed forest product continuum theory as proposed by Wiersum (1997). There is some reason to suspect that the concept of mono-specific tree production, based on high input-output treatments rather appears to have been developed by northern agricultural sciences, and that it has been transferred to forest product producers like in Kalimantan. It is not entirely clear whether this is explained by cultural reasons, or whether shifting to such high-maintenance tree crop production requires a technological leap that many farmers in tropical areas are not yet conditioned to make.

In addition, some of the findings from Kalimantan suggest implication for the concept of forest landscape domestication as suggested by Wiersum (1997). This concept, as especially Chapter Six shows, cannot only be understood from a narrow evolution of stand management perspective. Although single stand management evolves **-** as confirmed also by the cases discussed in this volume **-**, the presence and condition of forest in the landscape is more complicated than that. Not all forests in the landscape are managed the same way. While intensified forest management may be practiced in some areas, in other areas stands may be converted into less intensively managed forests, while they become both components of the same agricultural-forest landscape.

The value of these forests to their direct owners and society at large varies depending which function is considered, and what kind of management is applied. The biodiversity value of some of the managed forests remains high, relative to natural forests (Chapter Seven, de Jong *et al.* 2001). The biodiversity value, however, appears to be directly, and inversely, related to the amount of clearing that a managed forest stand receives. The impact of land use intensification in general and intensification of forest management, therefore, remains a complicated issue, and is difficult to be captured by some generalised trends.

4. REVISING THE CONSERVATION THROUGH COMMERCIALISATION PROPOSITION

The previous discussion suggests that early formulations of the conservation through commercialisation proposition were too narrow, and did not take into consideration several kinds of changes that FP commercialisation may trigger, for example, control of the trade by outsiders, or opportunities to shift to other more lucrative but less conservationists activities. Central to the new version of this proposition formulated here is the assumption that commercialisation of FP as a rule will lead to changes in production of FP, but that the changed modes of production will have a conservationists impact. Successful FP producers will most likely start a process of intensification that for a long time remains in a forest management stage, rather than an agroforestry or tree plantation kind of stage. These "indigenous managed forests" have a structure, architecture, and species composition that often compare favourably with those of natural forests (Chapter Seven).

Intensive production of FP as predicted by Homma (1996), and partly by Wiersum (1997) will also not occur easily. There are but a few examples where on the one hand FP become highly successful commodities, and are easily grown in plantations, such that this will lead to intensive production. Even the few examples that exist, like rubber, coffee, and oil palm, when adopted by swidden agriculturists in Kalimantan, may for a long time be produced under quite extensive growing conditions, leading to quite diverse vegetations. As argued by Neuman and Hirsch (2000), there are quite a number of conditions under which such a straightforward evolution of extractive economies will not occur. In some cases, even extensive or intensive management is not possible, as in the case of *gaharu* incense wood still collected from the wild these days in East Kalimantan (see Chapter Three).

The evolution of similar intensified production of FP under traditional forest management practices is difficult to predict. Under some circumstances, intensified traditional forest management production actually may contribute to processes of forest restoration, as shown in Chapter Six. Roughly, forest management intensifies, but intensified management is only applied on a limited area of the landscape. While this happens, other parts of the landscape may experience de-intensification. When forest management evolves, some forests are managed using new technology, while others remain under previous technology regimes or will be managed less intensively. This, however, is not easily to be generalised into a common pattern, as a recent volume on agricultural technological change and deforestation (Angelsen and Kaimowitz 2001) suggests.

An important conclusion from examples discussed here and elsewhere (e.g. de Jong *et al.* 2001) is that the evolution of traditional forest management systems may be hindered by unfavourable circumstances, like rent seeking activities by outside parties, inadequate policies, corruption of government officials, and the like. Where those kinds of conditions occur, intensified traditional forest management is likely to be replaced by other kinds of agricultural production, or by replacement of local people and their traditional forest management practices. More often than not, these changes will have a declining effect on the presence of forests in the landscape.

The new conservation-through-commercialisation- proposition recognises the opportunity to alter the pathway that a forest landscape will undergo from a situation in which only extensive extraction and management and little conversion occurs, towards a situation in which there are areas of intensified managed and less complex forests, together with less intensive managed forests. The opportunity for conservation through appropriate FP development consists in altering the pathway towards one in which there will be substantially larger areas of forest cover and structurally more complex and more diverse forests, than under alternative pathways without appropriate FP development.

CHAPTER 2
FOREST MANAGEMENT AND SWIDDEN AGRICULTURE: BACKGROUND AND SETTING OF THE STUDIES

1. INTRODUCTION

Swidden agriculture still remains a dominant land use in many corners of the world. Especially in tropical forest regions, however, this land use is usually part of a complex resource management that includes agriculture, forest product collection and forest product production in some kind of managed forests. This suite of productive activities as a rule combines production for household consumption and for trade in local or regional markets. Lastly, it is also common that natural resource management activities are combined with some off-farm activities, for the purpose of obtaining additional cash-income to cover expenses for goods not produced locally.

This chapter provides the introduction to the research setting where the Dayak Forest Management research was conducted, which provides most of the material for the subsequent chapters in this book. In addition, the chapter will investigate the complex of activities that include agriculture and forest management among swidden agriculturists in West Kalimantan, for the purpose of understanding how these different sets of activities relate to each others. This is a topic that needs to be understood first before going into the issue of the transformation of forest products procurement as will be done in Chapter Four, or other specific topics related to local forest management discussed in subsequent chapters. Agriculture and forest management, if conceptualised as distinct economic activities, both compete for limited productive resources, mainly of land and labour in the case of swidden farmers. The degree of competition depends on the scarcity of each of these productive resources. These facts warrant a detailed understanding of the relation between swidden agriculture, FP procurement, and forest management, before sensible proposals can be made for alterations in any of these economic strategies.

2. THE SETTING FOR THE RESEARCH ON FOREST MANAGEMENT IN WEST KALIMANTAN

Research leading to this volume was largely conducted between 1992 and 1995 in the district of Sanggau, located in the province of West Kalimantan, one of the four Indonesian provinces in the island of Borneo. It was conducted in three villages, Ngira, Teriang, and Koli.

The island of Borneo, with an area of 642,000km^2 consists of the two East Malaysian states Sarawak and Sabah, and the four Indonesian provinces of East, South, West, and Central Kalimantan. In 1990 the whole island had 12.7 million inhabitants, 9.1 million of which lived in the Kalimantan provinces. About one third of the people who live on the island are broadly classified as indigenous Dayak (Brookfield *et al.* 1995). Throughout the history of Borneo, the island has been of interest for the outside world for its natural resources. In the pre-colonial period the island was known for its various forest resources and minerals, and since the last several decades for its oil and timber. On the other hand, agricultural products like pepper and rubber have been important export crops since about the turn of the century. The production of oil palm also increased drastically since about the mid 1980s.

The changing economic importance of the island has also resulted in considerable social changes. In the Indonesian part, until two centuries ago, mainly Malay inhabited the coasts and riverbanks, while indigenous inhabitants lived in the interiors. Gradually various other peoples came to claim their niche: the Chinese, the Bugees from Sulawesi, and later people from other islands from the archipelago. The latter came as transmigrants or as spontaneous migrants. They all continuously pushed back the native Dayak to more remote places (see also Chapter Three). Together with the booming of timber and oil exploitation came the large scale opening up of large parts of West, South and East Kalimantan. This opening up was and continues to be followed by large scale agricultural development projects. The native farmers living in the remoter interiors rely for their daily staple on upland rice cultivation, produced in yearly cleared swiddens. In addition many swidden farmers grow other agricultural crops like pepper and rubber, especially in West and South Kalimantan, but less in East Kalimantan.

2.1 Geography

The three villages where the research took place, Ngira, Teriang, and Koli, are located in two sub-districts, Noyan and Jangkang, in the Sanggau districts, in West Kalimantan, Indonesia (See Figure 2.1). These two sub-districts are located roughly half way between the middle Kapuas river city of Sanggau, and the frontier between West Kalimantan and Sarawak. Both sub-districts are located East of the Sekayam river which used to be the main connection between the town of Sanggau and the northern interiors during Dutch colonial times (Mayer 1998). Today, to the east of Noyan lies a good asphalted road from Sosok to Entikong which is the through-way for traffic from Pontianak, the Capital of West Kalimantan, to Kutching, the Capital of Sarawak. Although this connection poses a good opportunity for cross border trade, the road across the border in Sarawak is of poor quality. The two sub-districts have semi-paved roads that connect to the Sosok-Entikong road South, from Kembayan to Balai Sebut, and North from Balai Karangan to Sungai Daun. Both roads allow year round traffic of all vehicles. The Northern road was being constructed while the study was being undertaken. Sungai Daun is the principal trading post of villages, like Ngira in the northern part of the Noyan sub-district.

Figure 2.1 Locations of study sites: Nigra, Koli, and Teriang in Sanggau, West Kalimantan

Villages in the area have the administrative status of *desa,* rural village, or *dusun*, which is often translated as hamlet. In fact a *dusun* still constitutes a Dayak community previously consisting of one longhouse or a few smaller longhouses. A longhouse is the traditional occupational structure in most parts of Borneo, and consists of single family sections that are constructed contiguously. Today each *dusun* is a village of mostly individual houses. The villages in Noyan and Jangkang are inhabited by language groups generally identified as *Bidayuh* (King 1993). These *Bidayuh* are a number of groups who occupy large parts of West Kalimantan in Indonesia and the First Division in Sarawak. In 1994, the age structure of the population in the area was about 33% of the population age 15 or younger, 46% between age 16 to 55, and 21% over 56 years old (Graefen and Syafrudin 1994). In general, most villages in the two sub-districts are accessible by motorbike. A few are accessible by car and truck. The most remote villages such as Teriang and Ngira and Koli can only be reached after walking trips that take from one to three hours.

2.2 Geology

Geologically the study area forms part of the Ledo Plains. The principal geomorphologic features of this plain are: (1) Hillocky sedimentary plains consisting of soil associations of Tropudults, Paleudults, and Plinthudults (all 20-60%) of moderate fine to fine texture. This geomorphologic feature appears to be most common in the eastern part of the Ledo plain, which includes the study area. (2) Undulating to rolling sedimentary plains which consist of Paleudult soils with a fine texture (> 60%) associated with Tropudults and Tropaquepts (each between 20 - 60%) both with a moderate fine to fine soil texture. (3) Hillocky acid igneous/metamorphic plains, with Tropudults and Paleudults (both 20-60%), and also of moderate fine to fine texture. The first two topographical features are derived from sedimentary rocks while igneous granite rocks appear to underlie the third one (RePPProt, 1990). In Noyan and Jangkang, the parent material is mostly yellow sandstone which was formed by marine tertiary sediments (Werner 1993).

The general uniformity of the plains are interrupted with long linear, high ridges or very steep cuestas, where folded sandstone strata have formed anticlines and synclines. Near Sanggau and in the middle Landak river area north of Sidas they reach altitudes of 250-300 m. Similarly ridges interrupt the plains as inselberg-like features in areas of igneous rocks, but these hills and ridges are of more compact shape and locally exceed 500-600 m altitude.

2.3 Climate

Under the Köppen system the climate in the area is classified as a tropical rainy isothermic climate with a hot summer, no dry season, and with double rainfall maxima. The annual mean temperature measured in Kembayan, about 30 km Southwest of Koli, is 27.5 °C, while the yearly fluctuation per month is between 27.3 and 28.8 °C. The average yearly minimum temperature is 22.0 °C, and the average maximum temperature is 33.1 °C. The average rainfall in the same recording station is 3131 mm/year and 261 mm/month, July being the driest month with an average of 129 mm. The mean relative humidity is 85% (RePPProt 1990). Some variation in rainfall in the area occurs due to the local influence of mountains. Ramon (1993) gives 119 rain days for Jangkang and 210 for Noyan.

The Regional Physical Planning Programme for Transmigration (RePPProt 1990) considers the area to which Noyan and Jangkang belong as having good development possibilities. The climatic conditions pose no problems for most arable crops, and two harvests each year should be possible in all areas of the Western plains and mountains. However, because of soil qualities the principal agricultural options in this region are considered to be tree crop production only. It should be noticed, however, that such assessment only takes into consideration the major environmental characteristics. On a smaller scale conditions vary and allow a combination of productive activities including more intensive agriculture, together with more extensive tree crop production and forestry.

2.4 The forests

The island of Borneo is known for its high and well developed tropical forests. These forests are among the most diverse in the world. Although the Bornean forests are best known for their high densities of trees belonging to the dipterocarp family, forests vary in species composition, and structure as a result of habitat variation. For instance, in West Kalimantan mangroves, forest on peat soils, freshwater swamp forest, heath forest, and lowland, or hill mixed dipterocarpaceae forest are found (Padoch and Peters 1993).

Recent studies have given higher numbers of area of critical lands (Tanah Kritis, land on which the forest has disappeared and on which an unproductive *Imperata cylindrica,* fern or shrub vegetation persists) in Kalimantan to 3million hectares, or 23% of the total area. Two thirds of these lands are located in West and Central Kalimantan. In West Kalimantan the main problem area lies in the hilly districts north of the Kapuas river, as far east as Sanggau.

In the two sub-districts, Ramon (1993) has distinguished 8 types of mature natural forests. These include lowland hill forest found on hilly landscapes with deep loamy soils, and flat lowland forest in a less undulated landscape. The two lowland forest types combined cover 20% of the three sub-districts. Especially those two types of forests are converted to agricultural land. Swamp forest is found in 15% of the two sub-districts. Different from the two previous types, most of its original area is still intact since swamp forest areas are only seldom used for agriculture as it has poor and acid soils. Dry and wet heath forests are both found on very poor podzolic white sand soils, and each type represents about 4% of the two sub-districts. Peat forest, which occurs on more than one meter thick peat soils, riverine forest, found next to the larger rivers, and submontane forests are each found on 1% or less of the two sub-districts (Table 2.1).

Table 2.1 Forest types in Noyan, Jangkang and Bonti*

Type	**Relative area**	**Tree species**	**Pole species**	**Soil**	**Trees dbh> 20cm /ha**
Hill forest	12.5%	148	259	deep sandy loam	192
Flat lowland forest	7.6%	83	101	deep sandy loam	160
Swamp forest	14.8%	55	105	silty loam and silty sand	287
Dry heath forest	4.0%	65	146	silty sand on white sand stone	?
Wet heath forest	4.0%	61	35	silty sand on white sand stone	200
Submontane forest	0.2%	102	?	loamy sand	?
Peat forest	0.8%	19	67	peat soils	264
Riverine forest	1.0%	?	?	sandy loam and clay	?

* (modified fromRamon, 1993)

The different forest types show a considerable difference in forest structure and species composition. Consequently, they contain very different forest resources for the local population. For instance, lowland hill forest has the highest number of tree species among the large trees (dbh > 20cm; 192), and in the pole size class (250). This species diversity decreases in submontane forest, flat lowland forest, wet heath forest, swamp forest and peat forest (Table 2.1). The tree densities, however, are highest in the swamp and peat forests and than decrease for wet heath forest, lowland hill forest and flat lowland forest (Ramon 1993). Although both swamp and peat forests have much higher densities in trees with dbh > 20cm, in those forests trees with larger dbh are virtually absent. The dominant trees occur in high densities, but have a relatively small diameter, and small crowns.

Although no recent estimates for Borneo are available, the spermatophyte flora of the island is probably between 10,000 and 15,000 species. Part of the richness of the Bornean flora is a result of the diversity of habitats, but is also a result of the island's unique location between two phytogeographic different regions east and west of the Wallace line. Because of the island's isolated location, and the diversity in habitats, a high species endemism occurs. For instance out of the 267 Dipterocarp species found in Borneo, 58% are endemic to the island (Ashton 1992).

2.5 The people

The *Bidayuh*, previously identified as Land Dayak constitute several different linguistic subgroups that originated from the Indonesian part of West Kalimantan, and are found as far South as the Ketapang basin (King 1993). The name was originally used to distinguish the non-*Malay*, and non-*Iban* inhabitants of Sarawak's First Division (Winzeler 1993). Their linguistic and cultural identity still remains unclear. They are distinguishable from larger groups as the *Iban, Kenyah, Kayan* or many other eastern and southern groups, because of their distinct culture and languages. However, they are so different from each other that they cannot simply be regarded as one cultural group. The indigenous people in Noyan and Jangkang are two of several dozens of these linguistic *Bidayuh* groups.

In his ethnographic inventory Yus (1992) distinguishes two main linguistic groups in Jangkang and Noyan. The people from Jangkang he identifies as such, *Jangkang.* This is the same name with which the people identify themselves too. In Noyan Yus identifies three different groups. The *Mump* and *Bare* are found in three villages, and the *Batang Kembayan* are found in the rest of the sub-district Noyan. The majority of the people from Noyan belong to the *Batang Kembayan*. Linguistically these groups are very close to the other two groups in this sub-district, as well as to two of the three groups in the neighboring sub-district of Kembayan. The language they use is indicated by Yus as *Kotek-koih*. This language is spoken in three sub-districts, Noyan, Kembayan and Beduai. The name that Yus (1992) provides for the Noyan people is not consistent with the names they give themselves. Ngira people name themselves as *Maté-maté*, a term they also use to identify the language they speak.

3. SWIDDEN-AGRICULTURE, FOREST MANAGEMENT AND LIVELIHOODS

Between 1992 and 1994 the research inquired about land use in the three villages through general socio-economic surveys. This included a full land use inventory in Ngira and Koli in 1995, using questionnaires that registered a particular set of data for every single field that people considered their own, be it swidden, fallow, rubber garden, forest gardens, or others.

3.1 Production of rice

Among most swidden agriculturist in Kalimantan the main staple is rice. Rice is not only important as daily food, but also for other social and ritual events. Rice wine and snacks are, for instance, important in the celebrating of the closing of the rice cycle, each year around April-May. Rice can be grown both in upland swiddens, here distinguished as *ladang*, and in *sawah* or irrigated rice fields. Both forms of rice production are found among Dayak in West Kalimantan (e.g. Padoch *et al.* 1998), but in the three research villages most of the rice production happens in upland swiddens. For instance in Ngira, four of the total 60 farmers reported to have *sawah* fields, while in Teriang only two of the 40 farmers had irrigated rice.

Despite the cultural importance of rice in swidden farmers daily diet (Dove 1993b) current production levels from swiddens hardly meet the yearly rice requirement. Hence, one of the most serious problems which Dayak face in their daily subsistence is insufficient rice production. One farmer expressed that the original forest on the location of one of his or forest gardens[1] had burned badly when he made the first swidden on that site 50 years ago, but that rice production had still been good enough. According to him, during those days there were still enough good sites to make swiddens. Even when a field did not burn well the yield was still satisfying. That is now not the case anymore. Newly made fields have to burn well to even have a hope of a good rice yield. Beside low soil quality of remaining sites where swiddens can be made, pests are a common problem too.

In 1992, yield levels varied considerably between Ngira and Teriang. In Ngira an average of 46 *jangkok* or baskets was harvested per household in 1992. Each baskets contains about 15 kg of thrashed rice. However, many farmers (25%) reported to have harvested only between 20 and 30 baskets. A total of 45% of the households did not yield at least 8 baskets of rice per household member, and thus did not harvest sufficient rice to feed the whole family well the whole year. Indonesia considers 0.3 kg of rice per person the minimum amount needed for daily consumption.

[1] Chapter Four discusses a particular type of forest gardens, called *tembawang*, as well as other types of managed forests.

In Teriang this situation was slightly better. The average rice production per household was 53 baskets. Of all the households 70.5% harvested more than 40 baskets. But still 39 % of the families had a yield of less than 8 baskets per household member. Only 20 % of all the farmers harvested between 60 and 70 baskets.

In 1993, farmers in Ngira harvested an average of 39 baskets per household, seven baskets less than the previous year. That year, only 36% of the households harvested 40 or more baskets. The situation was worse again in 1994, when the average number of baskets harvested had declined to 32 baskets. An equivalent number of households, 36 %, still harvested 40 baskets or more that year. In 1994, rice yields in Koli averaged only 22 baskets per household, and a total of 73 % of the households did not have an average of eight baskets per family member.

Although the data presented here show a decline in three years in the rice harvest yield in Ngira, it is still to premature to consider this as a proof of declining soil fertility in swiddens, due to increased frequency of swiddening on the same sites. On the other hand comments from the farmers mentioned in previous paragraphs do indicate such a process. Pressure on agricultural land is certainly present, but the data provided above are not tested against other possible causes of yield fluctuations in the three year period. On the other hand, the difference between the rice harvesting in Ngira and Koli is striking. The low average harvest of rice per family is most likely a result of more intensive land use, which is most likely the result of more frequent land use in Koli, compared to Ngira. However even in Ngira and Teriang rice production does not satisfy local consumption needs.

3.2 Rubber incomes and labour expenditures

Indigenous inhabitants from all over Kalimantan have been in contact with the outside world since ages. Residents in Ngira, Teriang and Koli obtain goods from nearby commercial centers and they trade a number of products, one of them being cash crops. Unlike in other Dayak communities (Claus 1991), in Ngira and in Teriang rubber is not the single most important cash crop. Several other products are sold. Still, in both villages considerable numbers of farmers possess rubber gardens, and many farmers intend to increase the area of this cash crop. In Koli, rubber is the single most important cash crop. Table 2.2. provides detailed information on ownership of rubber trees, and annual yield.

Table 2.2 Rubber in household economies in Teriang, Ngira, and Koli

Place & year	% h.h	Yielding trees	Daily yield	Tapping days	Total yield kg
Teriang 1992	30	218 (σ 144)	8.2 (σ 6.5)	36 (σ 23)	241 (σ 244)
Ngira 1992	58	591 (σ 950)	6.8 (σ 4.6)	55 (σ 44)	298 (σ 350)
Ngira 1993	60	Nd	4.4 (σ 2.6)	41 (σ 33)	159 (σ 145)
Ngira 1994	66	Nd	4.4 (σ 2.6)	34 (σ 28)	152 (σ137)
Koli 1994	83	555 (σ 681)	6.0 (σ 3.9)	46 (σ 38)	223 (σ 246)

A larger difference can be observed in the significance of rubber between the villages if one looks at the farmers who actually harvest rubber. In 1992, in Ngira 58% of the farmers reported to have an average of 591 trees that actually yielded latex. In 1992 in Teriang only 30% of the farmers reported to have an average of 218 yielding rubber trees. On the other hand, in 1994, in Koli, a total of 89% had rubber trees that could be tapped, and the average of trees per farmer was 555 trees. Average yields per rubber harvesting farmer was 298 kg in Ngira and 241 in Teriang. In Koli, in 1994 the 33 farmers who harvested rubber had an average of 223 kg yearly production.

Although rubber is a crop that can be tapped during most of the year, providing it does not rain in the morning, most farmers in the village actually harvest only very few days per year. In 1992 Ngira farmers harvested an average of 55 days, while in Teriang farmers harvested only 36 days. Furthermore, both in Teriang and Ngira many rubber owners allow others to harvest their rubber gardens. Where this occurs, the yield is equally shared between owner and tapper (identified as *bagi dua*). Some owners of rubber gardens reported that they did not tap their gardens themselves, but let others harvest their trees. In Ngira there were 12 farmers who reported to have sold an average of 113 kg of rubber, which they had harvested in somebody else's garden. In Teriang there were 14 farmers who had sold an average of 216 kg of rubber from gardens they did not own. Although there are fewer rubber gardens in Teriang, there is more sharing of these gardens than in Ngira.

Table 2.3 Products sold other than rubber in Ngira, Koli and Teriang

Commodity	**Ngira 1992**	**Ngira 1993**	**Ngira 1994**	**Koli 1994**	**Teriang 1992**
Pork (kg)	64 (32)*	40 (14)	42 (21)	28 (5)	88 (45)
Rice (kg)	109 (20)	39 (6)	493 (9)		278 (43)
Chicken (kg)	4.8 (20)	4.8 (32)	3.8 (19)	5 (3)	55 (5)
Pepper (kg)	166 (10)				132 (23)
Cocoa (kg)	9.7 (22)				
Tengkawang kg			128 (93)	94 (53)	74(11)
Shingles (#)	567 (5)	760 (10)	2750 (29)		3088 (41)
Ironwood beam			106 (19)	8 (3)	
Trees (#)			3 (1)		
Rattan mats (#)				1 (8)	
Hill myna (birds)	4 (25)	2.7 (20)	3.4 (13)		5.5 (45)
Gold (gr)		2.2 (30)	12.2 (40)		
Off farm (rp)	379,000 (25)	139,450 (52)	94,453 (61)		452,000 (14)

* Numbers provide averages for the groups of sellers only. Between brackets are the percentages of households who reported to have sold any of these products.

3.3 Other commodities

Table 2.3 provides a listing of other commodities that people reported to have sold in the three villages in which research was conducted. It appears, that next to rubber, the three villages only had the sale of pigs, and of chickens as a source of income in common. The most important of these two commodities are pigs as a source of cash income. Sale of chicken, however, was fairly constant in Ngira over three years. In addition, farmers in Ngira reported to have sold rice and hill myna birds (*Gracula religiosa religiosa*) for three years in a row. The fluctuation in sales of hill myna birds was the lower of the two, but still considerable as in 1992 a total of 25% of the farmers derived income from hill myna birds, but only 13% in 1994. This commodity was also very important in Teriang in 1992.

Off farm labour became increasingly important in Ngira between 1992 and 1994. This is a result from an increase in labour opportunities in the illegal gold digging enterprises in the neighbouring Balay Karangan sub-district, and in the ironwood extraction that began during 1993 and 1994 in neighbouring villages in Noyan sub-district. The high amount of off farm income in Teriang in 1992 **-** but for only 14% of the village inhabitants **-** is a result of several people owing a chain-saw which was bought with money obtained from working in Sarawak. These persons obtained considerable amounts of money when contracted to saw ironwood or other trees for own use or sale.

Noticeably in Table 2.3 is also the high incidence of people who reported to have harvested *tengkawang* (illipe) nuts in Teriang during 1992 and in Ngira and Koli during 1994. Although that year was a modest production year, and prices dropped fast because processing capacity in Pontianak had decreased over the last decade, still 93% of the Ngira farmers harvested this commodity that year.

Table 2.4 Average monetary income per household, and percentage contribution of different commodities

	Ngira 1992	**Ngira 1993**	**Ngira 1994**	**Koli 1994**	**Teriang 1992**
Monetary income/hh	331,168 (σ 356,270)	193,618 (σ 144,066)	429,458 (σ 708,502)	193,734 (σ195,065)	444,306 (σ 412,260)
Rubber	36.5	34.5	14.0	80.0	18.9
Pork	18.3	8.6	6.3	3.0	26.8
Rice	1.6	0.3	2.5		6.8
Chicken	0.8	2.4	0.5	0.3	1.7
Pepper	4.5				6.1
Cocoa	0.4				
Tengkawang			10.9	13.7	0.4
Shingles		1.8	3.7		8.5
Ironwood beams			26.5	0.9	
Trees			0.1		
Rattan mats				2.2	
Hill myna birds	9.0	9.6	2.7		16.9
Gold		6.0	19.3		
Off farm	28.7	37.5	13.5		13.9

3.4 Cash income

The total cash income per household in Ngira was Rp 331,000 in 1992. (At that time the exchange rate fluctuated around US$ 1 = Rp 2,200.) This decreased to Rp

193,000 in 1993, but went up to Rp 429,000 in 1994. Unfortunately we had only one estimate in the two other villages (see Table 2.4). The estimates in 1993 is possibly lower than in 1992, because in 1993 the survey was conducted one month earlier than in 1992. The proportion of rubber did not differ very much between those two years. Pork was relatively less important in 1993. That year, however, an increase in income from gold and from off farm work was recorded, a trend that continued in the next year. The largest part, 80% of the income from Koli was a result of sales of rubber. Noteworthy in the contribution to the income in Teriang in 1992 was the high percentage contribution of pork (27 %), ironwood shingles (8.5 %) and hill myna birds (17%). In 1993 many inhabitants in Teriang started to produce vegetables that were sold to Miro, about two hours walking distance, north of their village. This village had a temporary boom of medium scale gold mining. As a result Teriang inhabitants stopped entirely the sale of ironwood shingles. Inhabitants of Ngira went to work as eventual labours in the gold mining industry in Miro.

4. SWIDDEN LAND USE AND FOREST MANAGEMENT

4.1 Managed forests among swidden agriculturists in West Kalimantan

Farmers in swidden agricultural villages in West Kalimantan use land for a different number of purposes. This includes swidden agricultural fields, swidden fallow fields of different ages and different types of secondary vegetation (see Chapter Six), and other agricultural fields, like pepper gardens and irrigated rice fields. In addition fields are dedicated to rubber production, using a low weeding management regime. In other cases, forests are used to keep *tembawang* or mixed-fruit forest gardens, *pulau rimba* or privately owned forest reserves. *Pulau* can sometimes be planted with rubber (*pulau karet*), or with a mixture of trees (*pulau tembawang*). *Sompuat* are areas surrounding honey trees, which are preserved in order to assure an appropriate habitat for the honey bees (see Chapter Eight). *Agou* is forest that has been cleared from undergrowth, but not yet slashed. *Onian* is an area of forest that has been fully slashed, but was not burned, and therefore not planted.

4.2 Forests used for swiddens

Inland villagers in West Kalimantan still rely on agriculture to produce rice in yearly cleared swiddens. When swidden agriculture communities experience increased contact with broader market society the role of swidden in the economies changes. If land pressure increases, cropping cycles will be shortened, resulting in increasing labour investment to produce each time lower amounts of staple crop. In Kalimantan several examples can be shown where swidden production usually becomes replaced with either wet rice production, or with some kind of cash crop production (e.g. Padoch *et al.* 1998; de Jong 2001a).

Before this happens, swiddens are made both in primary forest and in swidden-fallow vegetation. In 1992, in Ngira only 58% of farmers had made a swidden in natural forest. The areas of swidden in this forest type varied from one to three hectares. Three % of the farmers reported to have made six hectares of swidden in natural forest. That same year, 36% of the farmers in Teriang had not made a swidden in primary forest. Most farmers (59%) who had made a new field in natural forests had used between 1 - 2 ha for this purpose. The average area of swidden in natural forest was 1.11 ha in Ngira and 1.11 ha in Teriang. This was a year of relative high area converted from natural forest, as the data presented in Chapter Six show an average annual encroachment of 0.64 ha/ family, calculated over a 10 year period.

Some 92% of farmers in Ngira had made a swidden in fallow vegetation in 1992, and 33% reported to have 2 ha of swidden in previously already used land. In Teriang, however, 25% of farmers had not made a swidden in fallow vegetation, while 39% of farmers reported to have a swidden in fallow vegetation of the size of 1 ha. Also fewer farmers in Teriang had larger areas of fallow vegetation used for swidden than in Ngira. The average size of swidden in fallow vegetation was 2.4 ha in Ngira, but only 1.6 ha in Teriang. In 1992 farmers in both villages used similar areas of natural forests, but that farmers in Teriang used less fallow vegetation to make swiddens.

Almost all farmers in the two villages reported to have an important reserve of land under fallow vegetation (see Chapter Five). In Ngira the total area of fallow land per farmer in 1994 was 14.3 ha. The average size of fallow vegetation land was 29.6 ha in Teriang. Most farmers (29%) had between 0 and 10 ha of fallow vegetation. In 1994 farmers in Koli had fallow areas of 18.9 ha on average per household. However, the percentage of fallow land in the village's total land use was almost similar with Ngira.

4.3 Rubber gardens

In Ngira 43% of all the farmers had no more than 5 ha of rubber garden, but of those only four did not have any rubber garden at all. In Teriang a total of 73% farmers had rubber gardens between 0 and 5 ha, and 14% of farmers had no rubber garden at all. More significant is the difference between the average size of rubber gardens per household. In Ngira the 56 farmers who reported to have rubber gardens owned an average size of 9.0 ha. In Teriang the average size of rubber garden was only 4.30 ha. The two villages also differed in the amount of farmers who had rubber gardens between 5 and 10 ha. There were 30% of farmers of this group in Ngira and only 20% in Teriang. In Ngira one farmer reported to have 90 ha of rubber garden. In Teriang the largest area of rubber garden reported was 20 ha.

4.4 Tembawang

Although *tembawang* is an important land use in the two villages, the total area of full grown *tembawang* forests is relatively small compared to swidden or rubber gardens. In Ngira, 57% of farmers reported to have *tembawang*, with an average of

1.1 ha per household. In Teriang there were only 32% of farmers who reported to own tembawang and the average size was 0.7 ha. On the other hand, recent changes in land use and rubber cash cropping appears to have had a positive impact on the planting of *tembawang* during the last ten years (see Chapter Six).

Table 2.5 Land use in Ngira and Teriang, 1992

Category	Ngira 1992			Teriang 1992		
	No. of owners	**Area per owner (ha)**	**Total area (%, ha)**	**No. of owners**	**Area per owner (ha)**	**Total area (%, ha)**
Number of swiddens	100%	1.7(σ 0.7)	104	95%	1.5 (σ 0.5)	62
Area swiddens in Primary forest	58%	1.9(1.3)	2.2 % (66.5)	64%	1.8 (σ 1.0)	3.3 % (49)
Area swidden in fallow	92%	2.4(σ1.4)	4.4% (129.5)	75%	1.6 (σ 0.8)	3.6 % (53.5)
Number of fallows	100%	10.9 (σ 11)	654	91%	14.4 (σ12.1)	576
Area under fallow	100%	37.1 (σ 46.9)	74.9%(2227)	91%	29.6 (σ 35.1)	80.5% (1182)
Area under rubber	93%	9.0 (σ 13.4)	16.9% (503)	86%	4.3 (σ 3.9)	11.1%(163.5)
Area under tembawang	57%	1.1 (σ 1.1)	12.9% (38.3)	32%	0.7 (σ 0.4)	0.6% (9.5)
Area under sawah	8%	0.6 (0.2)	0.1% (3)	5%	2 (σ 0)	0.3% (4)
Area under pepper	18%	0.7 (σ 0.5)	0.2% (7.2)	36%	0.5 (0.4)	0.5% (7.7)

4.5 Distribution of land use

The data from 1994 show that in Ngira the average farm holding is 25.2 ha resulting in a total area 1,687 ha of land under cultivation. The distribution of holdings is fairly even between the three lowest 10 ha size classes, (0-10 ha = 24%, 10-20 ha = 24%, 20-30 ha = 19%, see Figure 2.2). In Teriang the total land used by the 44 households added up to 1,469 ha, or 33 ha per household. The distribution of area per type of land use is presented in Table 2.5. The larger part of the land was fallow vegetation (80.5% or 1,182 ha). Rubber gardens occupied the second largest area (11.1% in Teriang or 163.5 ha). Swiddens occupied 6.9% in Teriang (102.5 ha). Farmers in Teriang reported only 9.5 ha of tembawang. In both Ngira and Teriang there are smaller areas of publicly owned *tembawang*. These are *tembawang* around previous longhouse locations where people planted trees in front or behind their particular housing section.

Figure 2.2 Distribution of holding size, Ngira 1994

Farmers in Koli had a total land area under cultivation of 1,147ha, or an average of 32.0 ha per household, more than 20% higher than in Ngira. There were no farmers who reported to have total holdings over 80 ha in size. On the other hand, the size class 0-10 ha was also much less represented in Koli (Figure 2.3). For the rest the general picture of distribution of total areas of holdings was comparable with the other villages.

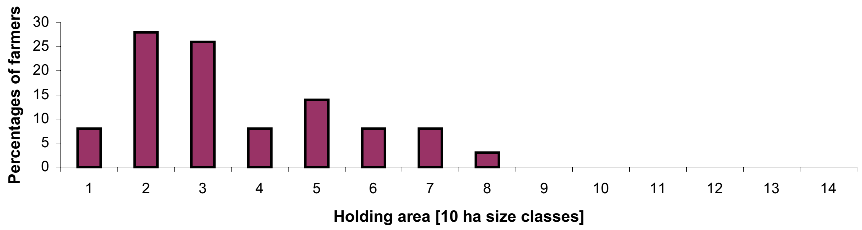

Figure 2.3 Distribution of holding size, Koli 1994

Table 2.6 Land use in Ngira and Koli, 1994

Category	% of villagers own	Ngira 1994 Area per owner (ha)	% of total area (ha)	% of villagers own	Koli 1994 Area per Owner (ha)	% of total area (ha)
Swidden	86%	3.2 (σ 1.8)	11 % (187.3)	81%	4.2 (σ 2.8)	11.0% (125)
Rubber garden	76%	6.7 (σ 5.5)	20.3%(343.7)	95%	8.3 (σ 4.4)	25.5% (291)
Fallow	100%	14.3 (σ 12.2)	56.7% (958)	95%	18.9 (σ 14)	57.9% (660)
Tembawang	36%	3.9 (σ 4.4)	5.6% (94.6)	51%	3.1 (σ 3.9)	5.2% (59)
Sawah	3%	2.0 (σ 1.4)	0.2% (4)	3%	4.0	0.4% (4)
Pepper	4%	1.0 (σ 0)	0.1% (3)			
Forest reserve	12%	1.3 (σ 1.2)	0.6% (10.5)	5%	3.3 (σ1.1)	0.6% (6.5)
Forest reserve with rubber	7%	1.1 (σ 0.7)	0.3% (5.5)	5%	2 (σ 1)	0.4% (4)
Forest reserve with tembawang	1%	0.5	0.02% (0.5)			
Field slashed, not burned	39%	2.6 (σ 1.8)	4.0% (68)			
Forest cleared, not slashed	10	2.6 (2.9)	1.1% (18.5)			
Sago				3%	0.1	0.01% (0.1)

The distribution of land use types, and the total area they occupy in Ngira and Koli in 1994 is provided in Table 2.6. The largest area is occupied by swidden fallow (*jamie*) followed by rubber (*karet*), swiddens (*ladang*), and *tembawang*. Numbers are provided for *agou*, or forest that has been cleared from undergrowth, *onian* or forest that has been fully slashed, but was not burned, and therefore not planted and *pulau karet* and *pulau tembawang.*

In Koli there were relatively more owners of rubber gardens than in Ngira, and the average size of rubber gardens was 25% larger compared to the average size in Ngira. Subsequently, the cover of rubber gardens was 25.5% in Koli, versus 20.3% in Ngira. Both swiddens and tembawang contributed similar proportions to the village overall land use in both villages. In Ngira 19% of the farmers reported to own some kind of pulau whereas in Koli only 10% of farmers reported to own such forest.

5. THE LOCATIONS OF FIELDS AND MANAGED FORESTS

Farmers in Ngira distinguish a number of land types, mainly based on topographic features. There are three types that are low lying, flat terrain located next to rivers, or enclosed by hills. These are *loba, tatei* and *tawa,* and are usually the more fertile and therefore more preferred lands. *Loba* and *tatei* are two lowlands next to rivers, forming part of the river floodplain, being *loba* the lowest of the two land types. *Tawa* are lowlands in landscape depressions, often where small streams begin. These areas are more often waterlogged than the other two lowland types, and they are the preferred sites to make *sawahs* or to plant rice that benefits from the natural moisture conditions. This *tawa* rice planting can often be done for subsequent years, or with much shorter fallow intervals than in other land types. *Tonyua*, *ngkuduk* and *dorit* are elevated lands being *tonyua* the lower hills, often adjacent to or surrounded by *loba* or *tatei* lands, *ngkuduk* are steaper hills, and *dorit* are slopes on tops of mountainous hills.

As a rule new settlements were started near a river of significant size. As the lower lying areas are preferred for rice growing, usually agricultural land is carved out first from *loba and tatei* land, and only when such lands are not available anymore people will start to cultivate *tonyua, ngkuduk* and *dorit*. This can be observed clearly in the relative distribution of land types in Ngira and Koli. In Ngira *loba, tatei* and *tawa* included 71.91% of the total area under some kind of land use or ownership claim (Table 2.7). Especially *tatei,* which is the best land for rice production as it has the same fertility as *loba*, but is less prone to infrequent flooding after heavy rains, covers 44.43% of the total village land area under some kind of cultivation or management. Surprisingly, in Ngira *tonyua, ngkduduk* and *dorit* differ only slightly in total area. This is most likely to be the result of availability of each of the land use types, as the steeper land types are less preferred because they are more demanding for the body. It was not possible to obtain a clear indication of difference in yield levels from *tonyua, ngkuduk* or *dorit*. Farmers did indicate, however, that invasion of *Imperata cylindrica* occurred much faster in *dorit* fields than in *ngkuduk* or *tonyua* fields, and that the frequency with which they can be used for rice production is lower than in other land types.

Table 2.7 Percentages, area per land use category and land type, Ngira 1994

Land use	**Loba**	**Tatei**	**Tawa**	**Tonyua**	**Ngkuduk**	**Dorit**	**Unspec.**	**Total**
Swidden	1.57	5.76	1.28	0.87	0.64	0.98	0.00	11.10
Rubber	1.39	11.29	1.16	3.27	2.81	0.44	0.00	20.37
Fallow	11.19	23.78	7.13	2.83	2.92	8.34	0.59	56.77
Sawah	0.00	0.00	0.18	0.06	0.00	0.00	0.00	0.24
Pepper	0.00	0.12	0.00	0.00	0.06	0.00	0.00	0.18
Tembawang	1.73	0.90	0.06	1.89	0.56	0.47	0.00	5.61
Forest reserve	0.00	0.06	0.00	0.12	0.09	0.00	0.00	0.27
Forest reserve With rubber	0.00	0.03	0.00	0.21	0.09	0.00	0.00	0.33
Forest reserve With tembawang	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03
Field slashed, Not burned	0.06	0.36	0.30	0.00	0.00	0.39	0.00	1.10
Forest cleared, Not slashed	0.71	1.88	0.58	0.30	0.24	0.33	0.00	4.03
Total	16.65	44.18	10.69	9.58	7.41	10.95	0.59	100.0

An important difference can be noted between the distribution of land use types under cultivation or management in Koli (Table 2.8). In this village, 38.23% of the cultivated land was of the *tatei* type. However, the total cover *loba*, *tatei*,and *tawa* was only to 41.42%. There was no use of *tonyua* land, but 46.19% of the land was on *dorit*. The two villages, Koli and Ngira do not differ very much in age. The difference in distribution of land types is a result of the availability of each of them. Koli has relatively much less *loba* and *tawa* land, and apparently no *tonyua* land. It may very well be that the larger area of land per household in Koli, and the larger areas invaded with *Imperata cylindrica* are a result of this different distribution of land types in the village. This difference in access to land types between the villages is of great importance to assess correctly what are the most appropriate options for agricultural, or forestry developments.

Table 2.8 Percentage area per land use category and land type, Koli 1994

Land use	**Loba**	**Tatei**	**Tawa**	**Tonyua**	**Ngkuduk**	**Dorit**	**Unspec.**	**Total**
Swidden	0.00	2.41	0.18	0.00	1.61	6.21	0.36	10.76
Rubber	0.71	14.20	0.00	0.00	3.75	5.58	0.45	24.70
Fallow	0.71	18.49	0.45	0.00	4.96	33.00	0.09	57.70
Sawah	0.00	0.00	018	0.00	0.00	0.00	0.00	0.18
Tembawang	0.89	1.85	0.00	0.00	1.92	0.45	0.00	5.11
Forest reserve	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.58
Forest reserve With rubber	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.36
Honey tree reserve	0.02	0.00	0.00	0.00	0.04	0.54	0.00	0.60
Sago	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
Total	2.33	37.89	0.82	0.00	12.28	45.78	0.90	100.00

6. CONCLUSIONS

6.1 Trends in cash incomes

Remarkable differences can be noted in sources of income from the forest comparing the three years. In 1992 only hill myna birds provided important contribution to incomes. The relative contribution of this commodity remained similar in 1993, but dropped in 1994. On the other hand, in 1994 *tengkawang*, ironwood shingles, ironwood beams, hill myna birds and gold contributed 63.2% to the total income in the village. In 1992 and 1993 the contribution from forest products was only 9.0 and 17.4. Especially the increase in sale of ironwood shingles and beams is a result of considerable improvements of the Balai Karangan-Sungai Daun road in 1993 and 1994. Because of this improvement entrepreneurs from Balai Karangan started exploiting ironwood in neighbouring villages Emputih and Semongan, and finally also arrived in Ngira about when this research ended. While this exploitation was going on in Emputih and Semongan, many ironwood owners in Ngira started to sell their own trees. Sales of forest products contributed 16.8% to total income in Koli in 1994, and 25.8% in Teriang in 1992.

The contribution of forest products to income not only fluctuated, but also was quite opportunistic in all but the rattan mats production in Koli. Although the percentage contribution of rubber in Ngira was much lower in 1994, the average production per family that harvested, as well as the number of families that reported to have harvest rubber in 1994 increased. The most important increase in monetary income came from ironwood, *tengkawang*, and gold sales. Ironwood sales and probably also gold sales are only temporary opportunities to obtain income; soon the resource will be exhausted. This is not the case with *tengkawang* harvesting. As much *tengkawang* planting and tending occurs, tree populations will increase rather than decrease. It is not known what effect of hill myna bird harvesting will have on natural populations. Catching of young must be seriously affecting the population. However, hill myna bird prefers open terrain and only nests in solitary trees, two landscape features that are now more common than in earlier days. Sales of shingles in Teriang lasted only for one year. It was a less preferable option because the product had to be carried for about six hours to the local buyer. Once road connections improve, this is likely to change however.

6.2 Trends in land use

The data presented above show the links between forests, forestlands and agriculture, which still continues to be the main economic occupation of inhabitants in the three villages. There are three trends that influence the integration of agriculture and forestry, as this chapter tried to describe. On the one hand, there is an increase in land under some kind of agricultural use. The main uses are swidden, swidden fallow or under rubber gardens. Especially the last kind of land use is still increasing in Ngira and Teriang, but has stabilised in Koli. As a result of this development a second trend that becomes evident is the utilisation of a larger suite of different types of land use for agriculture cash crop production. This has already happened in Koli, and is now taking place in Ngira and Teriang. The third trend observed in the three villages is an increase in capturing non-farm incomes. Part of the non-farm income stems from collecting forest products, but there is also a trend towards increased non-village based cash income.

Although the data in this chapter suggest rather a strong fluctuation in forest products incomes, without indicting a clear trend over the three years for which the studies collected data, it can be expected that some products will be faded out once the natural reserves become less than what makes them economically attractive. It is not clear right away, whether if there will be alternative products that will emerge. Most likely, rubber production will become more important in the near future. The incorporation of steeper lands in some kind of agriculture or agroforestry production eventually may be stopped as a result of people increasingly trying to obtain jobs that may be available, as has been reported from other places in Borneo (e.g. Ichikawa 2002). The next chapters, will discuss in more detail what the emerging trends are in terms of procurement of FP, new trends in local forest management, and the consequences for the forest landscape at the village level.

CHAPTER 3
A HISTORY OF FOREST PRODUCTS TRADE IN BORNEO[1]

1. INTRODUCTION

In a volume dedicated to assess the potential of forest product commercialisation in Kalimantan, it is useful to consider the history of FP trade in the region. Forest products have indeed been traded internationally from Asia's tropical forests since somewhere between the third (Peluso 1983) and fifth centuries (Watson Andaya and Andaya 1981). Most of interest here is how important forest product commercialisation was in the region, how the procurement and trade were organised, and who benefited from this trade. It can conceivably be argued that some of these past experiences can provide lessons for future development efforts. This chapter therefore will also try to highlight how local people have faired under increased commercialisation of forest products since it began some 17 centuries ago.

Researchers like Dove (1993a; 1996) and Neuman and Hirsch (2000) have expressed criticism on the opportunities for FP based development because of the widely observed problems with capturing the profits of FP trade. Therefore, this chapter will focus on the history of rent seeking activities among procurers and traders in FP. Rent is understood here as a surplus profit beyond the normal market return to labor and capital, which may be a result of scarcity of a resource, regulations, or monopoly. Rent seeking may include the creation of rent, or the capturing of rent (de Jong *et al.* 2002). In any kind of market economy, actors and their political allies will engage in putting up regulations that allow them to create or capture rent. It is part of the political economic game and it reflects the struggle between different interest groups. It are rent seeking activities by some that reduce the benefits captured by others. Rent seeking may occur because of differences in power between groups of actors in any trade. Common rent seeking strategies are, for instance collusion between a small group of traders, withholding information, coercion in the sense of using or threatening with physical force, and the like.

Practices of rent seeking are common in FP trade, and where they occur, they significantly limit the income generating opportunities of locally produced and traded FP (e.g. Neuman and Hirsch 2000). Consequently, this chapter will critically investigate the nature of rent seeking activities applied by the players involved in FP procurement and trade in Borneo and surrounding regions. Although the case study presented in this volume is from West Kalimantan (see subsequent chapters), historical information is mostly available from the Eastern part of Borneo, because

[1] Sections of this chapter have been used in: W. de Jong, B. Belcher, D. Rohadi, R. Mustikasari, P. Levang. The Political Ecology of Forest Products in Indonesia: A History of Changing Adversaries. Chapter in: T.P. Lye, W. de Jong, K. Abe (eds.): The political ecology of tropical forests of Southeast Asia: Historical perspectives. Submitted to Kyoto University Press.

early FP trade was most intensive there. Quite a number of historical researches have been conducted on early FP trade in East Kalimanta (e.g Peluso 1983; Sellato 2000). As a result, the information included here is slightly dominated by sources from that region. The chapter also includes some information from closely neighbouring regions. Some of the conclusions drawn from this material, however, are generally valid for other regions.

Sections two, three, and four of this chapter provide a brief overview of the main historical periods of Indonesia and how FP procurement and trade changed during these periods in the area being researched. These periods are pre-colonial and colonial areas, the period after independence and the period under the new decentralisation era. The chapter will make a few side-steps to neighbouring regions of Sumatra and peninsular Southeast Asia. The last section of the chapter will discuss the lessons that can be drawn from this historical overview.

2. EARLY FOREST PRODUCT TRADE

Early forms of FP trade in the Southeast Asian archipelago were concentrated in few areas and conducted under a socio political structure largely based on control of main access routes by rulers who held titles as sultan or king. The sultanates or kingdoms of these rulers consisted of little more than small settlements at the mouth of important river routes where it was possible to control the trade and collect taxes from this trade. For an important part the procurement and trade of forest products defined the socio-political organisation of entire regions where FP originated. For instance, the coastal economy of East Borneo, which for centuries was mainly based on smelted iron and gold, and on forest product extraction and trade (e.g. Watson Andaya and Andaya 1981; Peluso 1983), was dominated by sultanates and what Sellato (2000) identifies as "petty" kingdoms. These sultans and kings mostly came from Java, since about the 13th century (Peluso 1983). This coincided with a change in the regional trade politics that was largely dominated by China's recognition of Srivijaya as its main Southeast Asian trading partner. The Srivijaya kingdom, that flourished in western Sumatra between the eight and 12th centuries (Watson Andaya and Andaya 1981) held exclusive trading rights with China, the largest trading destination of much of the exports from Southeast Asia. The new policy within China, after the decline of Srivijaya encouraged establishment of many new ports in the archipelago. Vijayapura, in West Borneo, was a major port that existed together with Srivijaya. The expansion of Sultanates in East Kalimantan also coincided with the establishment of P'o-ni, supposedly the forerunner of Brunei port in northwest Borneo (Watson Andaya and Andaya 1981).

During that time, Chinese, Bugees and merchants of several other ethnic groups controlled the trade networks beyond the interior and coastal sultanates and kingdoms. They controlled trade networks for much of the pre-colonial period. In the western part of the region several Malay kingdoms controlled this trade between islands (Watson Andaya and Andaya 1981).

There is little evidence of any coercive methods to engage people living farther inland in the harvesting of products during this early trade. As long as population densities remained low and concentrated in the trade centres, states had limited control of the organisation of trade (such as domination of the collection and export networks) where the most profits could be obtained. There was not enough manpower to launch physical or military control over vast stretches of resource territories in the interior. Coastal rulers or traders and inland collectors did not dispute control over the resources. Partly, interior groups managed until recently to keep outsiders away from their territories, although they did fight among themselves over the resources that were in demand downstream (Sellato 2000). In East Kalimantan, the Kutai, for instance, operated for a long time as middlemen between the interior Dayak and the Bugees traders. They apparently went upriver to trade themselves, sent their agents, or received goods sent by the inland chiefs. The sultans levied taxes, not so much because they considered themselves owners of the areas where FP grew, but rather because they controlled vital parts of the transportation system. Mostly, upstream groups remained autonomous and eventually rebelled in case any downstream ruler tried to force them to direct their trade his way, impose heavy duties, or pay tribute in the form of rice and FP.

2.1 Early intensification of FP trade

Trade in FP from Kalimantan intensified from the 17th century onwards. This coincided with an overtaking of the control of the trade of the northern half of Borneo by the Sulu kingdom, formerly a vassal of Brunei (Watson Andaya and Andaya 1981). The Chinese and several ethnic groups from the archipelago continued to be in charge of the trade, but later it became dominated by the Bugees. The Bugees, who originated from Sulawesi, initially had spread to Java, Palembang and Jambi, after conflicts in Sulawesi partly fostered by the Dutch to increase their control of the island and the region (Watson Andaya and Andaya 1981). These refugees came into conflict with local authorities and eventually moved on to remoter places like the southwest and east coast of Borneo. The Bugees traders gained considerable political power because of their seafaring skills and trade connections. Eventually the Dutch were to take control of the FP trade, but not until the 20th century.

The fight over direct control of the FP source areas also intensified once downstream demand increased. Marriage and blood brotherhood became common ways to bind tribal groups to downriver kingdoms (Sellato 2000). In East Kalimantan, for instance, the Taogus, one of the groups of the region, tried to intermarry with the native women to increase control of birds-nests caves. This was largely unsuccessful because, by that time, the Kenyah, one of the more powerful interior Dayak groups, started to control some of the forest product resource areas through coercive measures. As a result some tribes who had collected for the Taosug became too scared of the Kenyah to continue going into the forest (Peluso 1983). Efforts to use coercive measures by downstream parties reportedly were largely unsuccessful. The Taosug, in addition to finding alliances, also attempted to control "host" populations in the interiors where they settled to control FP trade. They used raiding for the sake of trade but eventually were themselves raided out by the Kenyah (Peluso 1983).

2.2 The new rulers from abroad

Although the Dutch gradually took control of Java and Sumatra since they arrived in this part of the world, the Bugees continued to maintain control of the trade with the coastal towns of Kalimantan until almost through the 18th century. Although the Dutch had managed to establish a trading post in West Kalimantan, they were forced to abandon this post towards the end of the 18th century. Into the 19th century the control of West Kalimantan remained problematic, in part because the Chinese had been moving steadily into this area, and their *congsis* defied even the local sultans and controlled rivers and territories (Lublis 1990). Partly because of the lack of control they could exercise over places outside Java, throughout the 19th century, the Dutch established a rule system that identified regions like Kalimantan as self-governed lands (Vargas 1985). It was, for example, not until the 1930s that the Dutch achieved a "semblance of control" in the upstream regions of East Kalimantan where trade in birds nests was one of the lucrative sources of revenue (Geary & Eaton 1992). However, the Dutch still had to grant ownership of these caves to some of the coastal rulers, which they continue to hold today. During the period 1880-1920 traditional FP trading channels continued side by side with the emerging Dutch-controlled trading channels, as the Dutch were unable to impose their rule of law and claim taxes. In the 1920s, however, the bulk of the FP trade came under Dutch administration (Sellato 2000).

The interior groups became heavily involved in FP exploitation and trade after 1850, and the mostly remote groups in this region since the last decades of 19th century, when demand for certain products (e.g., *gutta percha*) intensified (Sellato 2000). While this happened, trading posts moved upstream to tap ever more remote regions. The petty kingdoms, especially, moved inland as they opened remote areas to trade and bring into partnerships with them leaders of more isolated tribal groups. To get access to trade resources, these kingdoms would strike deals with tribal chiefs rather than force them into trade. For the petty kingdoms often competed among themselves to set up favourable partnerships with those inland chieftains that held exclusive access to resource-rich territories.

2.3 Inland fights over forest products

One result that intensified trade of FP had, is increased control over resources between different groups or within different groups. Several of the East Kalimantan groups, like the Kayan, Kenyah, or Merap, have stratified societies that include aristocrats, commoners, and slaves. Once bird nests became increasingly demanded from caves in East Kalimantan, often the leader or the elites within the stratified groups appropriated these resources. Aristocrats, for example, had primary rights to the resource and could demand a share of the harvest. In some cases neighbouring groups could collect FP only with the permission of the aristocrats. For instance, Punan inhabitants in some locations could collect rattan in the territory of Kenyah villages, but they had to pay 20% of their harvest to aristocratic leaders. The aristocrats could decide when to organize collecting trips of FP for the purpose of trade, as well as the trading trips themselves. It implied that the petty kingdoms downstream made deals with these chiefs and nobody else. These chiefs got official recognition by the trading kings, the sultan, and the Dutch administration, for instance in the case of bird nests caves.

One consequence of the commercialisation of FP was a growth in tribal warfare from 1830 onwards. Due to increased demand from the Chinese, a resource over which conflicts grew were the sites of bird nests (Peluso 1983). The groups who could extend their control over bird nests caves were the warlike groups, like the Kenyah and Merap, mentioned earlier. The Segai Kenyah, for instance, displaced weaker groups located close to the best caves (Peluso 1983). Much of the contemporary geographic distribution of groups in Kalimantan can be explained as a result of fights over and claims to the control of forest product resources.

3. FOREST PRODUCTS TRADE IN A FREE INDONESIA

Indonesia declared independence in 1945. The first years after independence featured an ideology of reinforcing the rights and opportunities of those who had hitherto been oppressed. The new nation formulated a number of important laws and regulations to deal with its forests and forest resources it contained. Several of these laws created opportunities for legally recognized exploitation of FP by local groups. The constitution formulated soon after independence declared all natural resources as the property of the state, which was to be used for the maximum prosperity of the people (Weinstock and Sunito1989). Provincial and district governments were given the right to grant permission to collect timber and non-timber products in the new nation’s forests. The era of sultans and kings was definitely over. Their roles in the FP trade had effectively ended. The non-indigenous traders also were looked at with suspicion, and they had little opportunity to continue their profession through the first years of independent Indonesia.

This progressive trend started to change with the Basic Agrarian Law of 1960. This law allowed the possibility of overruling customary law considerations whenever national interests were at stake. The Basic Forestry Law of 1967 called for research and development of FP for the betterment of the people living within or near the forest (Weinstock and Sunito1989). Government decree 21 of 1974 defined the conditions under which logging of timber could take place. It did create the opportunity for FP concessions of up to 100 ha and for periods of 6 months, providing these concessions did not hinder logging activities. A subsequent government decree revised number 21 of 1974, and did away with the FP concessions (Sirait pers.com[2]). Only in 1995, after much lobbying from the Indonesian NGOs and other advocates, a new legal instrument was created that allowed communal concessions for collection of FP.

Subsequent practices reflect this ambiguity in forest-related legislation. Since 1970, there has been an unprecedented exploitation of Indonesia's natural resources. Part of the trend involves adoption of increasingly coercive measures meant to transfer FP benefits away from those who previously had managed to make a reasonable living out of these sources. This process was most severe in the 1980s when a widespread onslaught on Indonesia's forest was fully under way.

3.1 Modern disappropriation of forest products

Rattan has been widely collected in Indonesia since 1835 (Sellato 2000). Somewhat later in South Kalimantan rattan suppliers began planting rattan in gardens (Belcher *et al.* 2000). Rattan trade and cultivation gained increased importance after independence and over the subsequent decades prices went up. By the end of the 1970s rattan had become the main source of income for many villages in regions of East Kalimantan.

In East Kalimantan, rattan was the raw material for manufacturing mats (*lampit*). This product gained increased international demand from 1985 onwards, mainly because of the use of *lampit* in Japan (Abe 2002). Exports grew from an annual average of less than 1 million m^2 to 4.9 million m^2 in 1985. In line with other efforts to increase benefit capture of natural resources at home, the government decided to ban the export of unprocessed rattan. As a result the domestic processing industry expanded substantially. An additional consequence, however, was a drop in the price of the raw material, and thus in the income of rattan producers. In effect, the ban on exports of raw materials became a subsidy for domestic processors by reducing the total demand for rattan – at the expense of collectors' incomes (Belcher *et al.* 2000).

Worse, however, was still to come. Eventually, the supply of *lampit* started to exceed demand while the excessive production led to a decline in quality and a corresponding decrease in price per unit. At this point one of Indonesia's best-known timber tycoons, Bob Hassan, saw his opportunity. He established the *Asosiasi Industri Permebelan dan Kerajinan Indonesia* (Association for Indonesia Furniture and Handicraft Industry, ASMINDO). In 1989 ASMINDO approached the Industry & Trade Department with a proposal to prevent unhealthy competition among rattan mat exporters. The proposal contained a trade policy, including a quota

[2] Martua Sirait. International Center for Reseach on Agroforestry, SE Asia Office, Bogor.

system to manage the supply. In addition it suggested imposing export restrictions. Since that time, traders have had to get approval from the ASMINDO office in Jakarta to export *lampit*, on top of which they had to pay a fee. Many individual manufacturers have since reported that the quotas were assigned based on political connections and payments.

The effects were devastating. In East Kalimantan the 1989 ban on export of semi-processed rattan caused a decline in production, dipping from 13,500 tons in 1988 to 3,203 tons the next year and, finally, to 1,549 tons in 1991 (Sellato 2000). Although the price of raw materials remained the same, the demand went down and in many locations people could not sell their rattan any longer. For the next three years after the 1989-imposed regulations, *lampit* exports dropped to between 1.6 and 1.9 million m^2. It went up to 3 million m^2 in 1991/92 but dropped again to 1 million m^2 from 1996/97 onwards. The unit price of *lampit* dropped from US$ 6.38 to US$ 1.22 between 1987 and 1990, but went back up again to US 8.39 in 1995 (Belcher *et al*. 2000).

ASMINDO blamed Japanese consumers for this declining demand. Indeed, very soon after the export of *lampit* from Indonesia started to drop, imports from China, of mats made from bamboo strips, went up. The bamboo mats from China matches the export levels of rattan mats from Indonesia. This does suggest that the attempt by ASMINDO to control the industry actually favoured conditions for a competitor using a close substitute to take over the trade (Belcher *et al*. 2000).

3.2 Military might and forest products raiding

The more stunning example of coercive action related to FP is the case of *gaharu* incense wood, again from East Kalimantan. The *gaharu* trade in East Kalimantan started relatively late because the quality was lower than that found in other collecting regions (Momberg *et al*. 2000). However, when supply of the higher quality gaharu from other places ran out, traders turned their attention to this region. Together with rattan, demand and prices for *gaharu* increased from the mid eighties onwards.

In 1984-1985 the company PT Saguaro, owned by the Indonesian Army's Special Forces, Kopassus, came to East Kalimantan. They ordered all the *gaharu* traders to sell their entire stock to the company and simply forbade them to buy anymore from collectors. All the collectors had to sell exclusively to the company. Over night this company took over the entire *gaharu* trade by force and intimidation. However, even though they used coercion, the company did not stay in business long, to some extent because of lack of collaboration from the population.

The company also established bases in villages, "conscripted" traders, and forced people to go on *gaharu* collecting trips. In that time, no other FP were collected. During the 1990s, army helicopters, supposedly assigned to patrol the vast border area between Kalimantan and the neighbouring Malaysian states of Sarawak and Sabah, exploited their access to airspace and dropped teams of collectors into uninhabited forest areas to extract *gaharu* for dispatch to Samarinda.

4. FOREST PRODUCTS UNDER DECENTRALISATION

In April 1998 Suharto was forced to step down from power, marking the beginning of yet another period of profound change for the country. The post-Suharto years were marked by the call for *reformasi* (reformation) and an end to "KKN" (*korupsi, kolusi, nepotisme*)[3]. These calls have led to a new way of doing politics in many parts of the country. They have paved the way to public discussion of issues, open expression of disagreement on current affairs among wide sectors of the country, and the bringing to justice of many abusive officials and business people, like Bob Hasan, who had enriched themselves during the Suharto regime.

The new government undertook revisions of the various legal instruments that were widely perceived as allowing the exploitation and degradation of the national resources of the country. Already the constitution has been amended to give more attention to private, economic, and socio-cultural rights. It also proposes genuine political autonomy of indigenous communities. In future amendments, adjustments are to be made to better define the rights of the state in relation to natural resources. Alternatives being weighed are whether the state should continue to have the right to assign resource ownership, or whether state powers should be limited to regulating administration. The outcome of these discussions may have important implication for other sector-based legislation.

Several proposals are on the books for new legal instruments that favour FP use among primary producers. One proposed government decree basically goes back to the former practice of recognizing customary rights. This would allow for legally recognized communal forest management and communal rights to harvest timber and non-timber, even in lands that continue to be classified as state forestland. This would be more applicable to traditionally managed forests, such as *tembawang* or rattan gardens in various parts in Kalimantan (see chapters Four and Six). In addition, the new proposals allow communal concessions, again for both timber and non-timber, and small concessions for other legally entitled parties. The latter could be for timber or non-timber, but not for both simultaneously (Sirait pers. com.).

Unfortunately, political reform has coincided with one of the biggest ever economic crises in Indonesia and regionally. This had particular bearing on FP collection and trade because some of the planned options to stimulate economic recovery are the production of estate crops in remote areas of the country. Oil palm and industrial

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[3] Indonesian words for "corruption, collusion and nepotism".

timber production are favoured candidates for entrepreneurial investments; other crops like rubber are also slated (Potter and Lee 1998; Casson 2000).

On top of these developments Indonesia is finalizing a profound decentralisation program; the roots of this process began some time before the fall of Suharto. This again will have profound influences on how forests and their products are dealt with. There is still little evidence on the final outcome of this new tension between on the one hand a democratisation that includes giving back the forest to the people, and on the other the political and economic decentralisation process, which gives more decision-making powers to local officials. The initial developments are worrisome, as the account below suggests.

Already before the collapse of the Indonesian economy, estate crop development and industrial timber developments were on the rise. Production of oil palm is representative of this trend. Potter and Lee (1998) and Casson (2000) have in detail assessed the tremendous interests behind the oil palm boom and how this boom has led to a grab for land in several of Indonesia's outer islands. For instance, a large part of the province of West Kalimantan has already been given over as concessions to oil palm companies, for future plantation development; current land uses or small farmer claims to the land are disregarded in this process (Potter and Lee 1998). By 1998, an estimated 70,000 ha were planted to oil palm in East Kalimantan (with substantially larger areas in neighbouring provinces). Nearly 4 million ha have been designated for conversion in East Kalimantan and applications had been approved for more than 450,000 ha to be released by 1999 (Casson 2000). Provincial and district officials are interested in oil palm over other possible economic development options because it promises quick economic returns for the region (Potter and Lee 1998).

The companies interested in plantations proceed in different ways. From West Kalimantan there have been reports of the acquisition of land from local swidden agriculturists. This somehow suggests a de facto recognition of property rights, or possibly an acceptance that it is cheaper to pay outright for the land than to contest local property claims. In addition, some of the land acquisition efforts were conducted using measures like bringing along government officials or military personnel to persuade local farmers to go along with the "proposed" transactions (de Jong 1997). In some areas of East Kalimantan the establishment of oil palm plantations has already led to displacement of large numbers of people and the destruction of rattan gardens (Belcher *et al*. 2000). More recent efforts to continue these actions have led to serious conflicts. Reports mention the highly coercive actions of companies like P.T. London Sumatra, which include malicious destruction of rattan gardens and forest by the company. The locals retaliated to these actions by setting to vehicles and buildings and uprooting oil palm trees (Belcher *et al*. 2000).

The coercive occupation of land previously used for FP production was still largely a relic of the pre-*reformasi* period. However, it cannot be ruled out that similar practices will continue for several years at the provincial and district levels, because of the new powers lower level state officials now hold, and because of the need for districts to raise their own incomes. A more structural problem that may seriously affect primary producers' future earnings from FP is the way oil palm is favoured and promoted by district officials.

Growing oil palm and related cash crops is attractive to local FP producers because these crops can be incorporated into a larger suite of activities that provides more security of income than is possible with narrow economic strategies. Oil palm companies and regional officials, on the other hand, prefer to exclusively promote widespread oil palm production and eliminate any other land use activity. In addition, the persistence of, for instance, rattan trade barriers continues to artificially reduce the domestic price of the raw material. This includes illegal fees charged to traders and official export taxes (Belcher *et al*. 2000). This conjunction of factors leads to the ironic situation in which there is a growing international demand for rattan but large numbers of producers in Kalimantan are abandoning their rattan gardens to join government-sponsored or private oil palm projects. Potter and Lee (1998) have pointed out the mixed experiences of former swidden cultivators who joined smallholder oil-palm production schemes, becoming specialists where they used to subsist on a combination of agriculture, FP collection, and other cash generating activities. The risk of worldwide overproduction of oil palm, and possible price declines, put these previously diversified producers at great risk.

5. LESSONS LEARNT AND CHALLENGES AHEAD

This historical overview shows that FP have played an important role in the economies of several insipient states, an importance that continued through to the colonial area and into the period of modern Indonesia. In fact, only since the 1970s became timber the most important forest product in terms of total value exported (de Beer and McDermot 1997). The evidence presented in this chapter also suggests that whenever forest products became commercially attractive, outside actors became interested and started efforts to take control of the trade, and later even of the resources themselves.

Throughout the history, participants in FP trade have engaged in rent seeking to increase the share of their profits. This rent seeking took different forms, from cooperation and collusion between traders, or between traders and politician, to blatant coercion from the part of the Indonesian Military. Fighting over FP rich areas also became common among the inland groups.

The control in the early eras of FP commercialisation from Kalimantan, however, was only limited to places where the traded products necessarily had to pass through. Early elites could not get control of the primary resources itself, nor of the upstream trading networks. However, as resources became more valuable, and as those in power became more sophisticated, this control could be extended upstream. Initially the local elite moved each time farther upstream to control the trade, but eventually it were the Dutch who took over this control, followed by the new business elite in the Indonesia under Suharto. This suggests that the evolution of control of forest product trade has been towards an increased control of the trade close to where procurement takes place, but by a group of people who each time were located farther away from the areas where FP were produced.

This picture is now drastically changing. Considering the recent reform, and decentralisation trends, it is unlikely that any rent seeking or coercive capturing of FP trade will be possible out of Jakarta, as it used to happen under the Suharto regime. However, there is still little guarantee that this will not continue to happen at the district level. On the one hand, there will continue to be opportunity for local officials to benefit from FP trade, while economic development proposed by the same district officials may again favour a local business elite, but less the FP producers. In addition, other land use opportunities will continue to pose a threat to FP production from forests, jeopardising any FP based development or conservation efforts.

Probably new challenges that will become increasingly apparent in the future are FP production and trade under new regulatory regimes that necessarily will have to be put in place nationally and at the district level. Such regulatory regimes are necessary to define in much more detail the rights and responsibilities of civil society, and the mandate, authority and obligations of district governments. Even under a scenario where there are no or only few actors engaging in blatant rent seeking, there will be an increasing need and desire to regulate any type of economic activity based on forest products, be it for the sake of levying the necessary district taxes or be it for the sake of protecting the multiple functions of forests. There is increasingly evidence that this kind of institutional development may become a constraint to local FP production, processing and trade, and it will likely single out the few cases of FP that have a wide demand, and for which traders will be able to afford the transactions costs that necessarily will increase under such a scenario, from those that have much lower demands, and that yield lower returns. This, beside rent seeking of actors in the FP trade, will likely become a new challenge for FP commercialisation in places like Borneo or elsewhere.

CHAPTER 4
THE TRANSFORMATION OF FOREST PRODUCTS PRODUCTION

1. INTRODUCTION

The importance of forests for people living in, or near the forest has been recognised in many studies on rural economies. Since the late 1980s an increasing number of studies have been produced that record the economic dependence on forests and the many products that they yield. It is difficult to come up with a general pattern of forest dependency, or the contribution of forest to monetary or non-monetary income. Wunder (2001) estimates an average net income contribution from forests of around 25% in many studies. This number, however, varies substantially from place to place. Examples with much higher contributions and lower contributions can be found (e.g. Neuman and Hirsch 2000). In addition, substantial variation in income between different groups within single villages has recently been reported (Cavendish 1998; Braedt 2001).

While economic dependency on forests is still prevalent, it is also changing profoundly among many forest dependents. Today, even the remotest groups of forest dwellers participate in some degree in a cash economy. In most cases, this implies that the suite of economic activities that characterise livelihoods changes constantly. Often this may coincide with a declining supply of goods from forests. In the case of changing contributions of FP to household income, one can hypothesise two different scenarios. On the one hand, economies may evolve and increase in monetary income outstrips the declining supply of FP, such that people turn increasingly to goods that can be obtained in markets (e.g. Cavendish 1998). FP collectors, in this case, will spend little extra effort to obtain FP they used to obtain from forests. Alternatively, the decline in supply may not be compensated by an increase in monetary income. In this case, it can be expected, that, beside trying to increase monetary income, there will be a response among the FP producers to somehow sustain a supply of FP that used to be available before.

An issue that is less often reported in the literature is the kind of changes that take place not directly related to sustaining or increasing monetary incomes. In most studies that look at changes in FP supply, and the consequences for net family income, little or no attention is paid to alternative actions that FP consumers undertake to make up for the changes in supply from forests. This chapter aims to look at some of these responses in terms of changes in the origin of forest products that stem from different types of forests. In particular this chapter will look at changes in forest management as a consequence of the changing economic and ecological environment.

Forest management, which includes protection or cultivation efforts/ like tending of species, thinning, and even planting, to assure or increase the supply of commodities from forests, is now increasingly being documented among rural dwellers (e.g. see Wiersum 1997 for a review). However, there is still little understanding of the relationship between forest products supply and the practice of management in economies in transition. This, in fact, implies that it is often little understood what kind of investment, other than collecting, goes into the procurement of FP, before they can be consumed, or reach the first level of traders.

This chapter will look at forest products supply among swidden agriculturists forest managers who are experiencing processes of change. These changes are reflected in a diminishing supply of forest products, because of the changes in the natural forest landscape. Although there are indications of decreasing supply, there is also evidence of adaptations in forest management practices that are aimed at compensating this decreasing supply.

The first section of this chapter looks at changes in the procurement of a few selected forest resources that have a relatively high importance among Dayak swidden agriculturists in the interiors of West Kalimantan. These forest resources are game, honey and rattan. Game used to be the principal supply of protein among many swidden agriculturists in interior Borneo, although the supply of this resource is changing drastically as consequence of hunting pressure. Honey, the second resource that will be discussed here, comes from one type of managed forest, the *sompuat* or managed honey trees. If managed for the specific purpose of yielding honey these trees are kept in a surrounding forest environment, and therefore become *de facto* managed forests. Rattan is one of the best known FP from Kalimantan, and it has been traded from the island since mind 19^{th} century (Belcher *et al*. 2000). Data on these products were collected during socio-economic surveys held between 1993 and 1995 in the researched villages, completed with additional unstructured interviews.

The second part of this chapter looks at the supply of forest products from three types of managed forests: *tembawang* or mixed-fruit forest gardens, *pulaut rimba* or privately owned forest reserves, and *hutan tutupan* or communal natural forests reserves. These are three out of six types of managed forests that are found in this region (Table 4.1). These forests include three types of protected mature natural forests and three types of forests, which are usually found on land previously used for agriculture. The three types of managed natural forests are: (1) *hutan tutupan*, communally maintained areas of natural forests, (2) *pulau rimba*, forests islands, which are privately owned patches of natural forests because the owner made agricultural fields all around them, and (3) *sompuat*, areas surrounding honey trees, which are preserved in order to assure an appropriate habitat for the honey bees (see Chapter Eight). The managed forests, which occur on land previously used for agriculture are: (4) *tembawang*, fruit-forest gardens, (5) rubber gardens which are mixed with many other species, and (6) secondary forest.

Table 4.1 Managed forests in Dayak villages, West Kalimantan

Forest type	Description
Hutan tutupan	Communally protected forests
Pulau rimba	Mature natural forest islands
Sompuat	Honey tree forest islands
Tembawang	Fruit-forest gardens
Kebun karet	Rubber gardens
Bawas	Swidden fallow secondary forest

It is a difficult task to obtain reliable data on the actual economic returns from such managed forests partly because harvesting, and any activities in general in managed forests are carried out randomly and casually (e.g Padoch and de Jong 1989). Harvesting of forest products is often done when people happen to pass through those forests. Furthermore, the right to harvest forest resources is often shared with many people. In the case of *tembawang*, for instance, many more people than only the owners may sometimes harvest products, making it very difficult to obtain reliable estimates on total economic returns.

In order to estimate the economic potential of these forests, and their actual economic contribution, during 1993 and 1994 the uses of all species were recorded. The inventory of uses may reveal species, which are actually only seldom harvested, and therefore are not reported during surveys on economic returns. For the evaluation of the economic importance of Dayak managed forests in Teriang and Ngira both the use value of species and information on the direct economic returns was obtained during interviews with owners of plots of managed forests selected for study. The uses and the cultivation status of all the 630 species (see Appendix 4.4) recorded in the inventories of *tembawang*, *pulau rimba* and *hutan tutupan* were principally investigated with the aid of two informants. Several times, however, the uses of species were discussed with several more people who just happened to be present at working sessions. The information on uses of species was constantly checked when herbarium collections were being made in the field.

2. ADAPTING PROCUREMENT OF FOREST PRODUCTS

2.1 Game

Game is one of the most important sources of proteins among many swidden agriculturists in Kalimantan. Chickens and pigs, the other protein source, are consumed, but also traded or consumed during festive or ritual events. The smaller rivers in the interior of Kalimantan, where most of the Dayak swidden agriculturists villages are located, yield little fish. Although catches are on a decline, inhabitants from Ngira, Teriang and Koli still go out hunting on frequent trips, especially outside the seasons in which swidden preparation, planting, weeding, or harvesting require full attention.

Hunting habits have remained the same, despite declining catches. Inhabitants of Ngira, Teriang, or Koli may undertake hunting trips individually, or in smaller or larger groups. Most people actually prefer to go in groups, as it is expected that larger groups will be more effective in actually finding and killing game. These larger groups do not really agree on departing together but some people announce their plans that they want to go hunting the next day. This news is passed on, and once the moment to start the hunting trip has come, people start gathering somewhere near to the village centre. Anybody who wants to joint the hunting trip comes along and, when some game is caught, receives his share of the game. Once the hunting trip is over, and some game has actually been caught, people get together, usually near a water source, to butcher the game and divide it up in equal parts for everybody who joined the hunting trip. Only the person who actually killed the animal or animals gets a larger share.

A total of 48% of the households in Ngira reported to have gone hunting in 1993. The cumulative number of times that this group went hunting was 396 times or 7.92 times per household. However, only 117 hunting trips, or about one out of three times, was successful. In 1994 a total of 51% of the households went on any hunting trip, almost the same as in 1993. That year, however, the cumulative total of hunting trips that people participated in was only 278 times, or 3.97 times per household. Only 94 out of those 278 were successful, similarly one out of three times.

For 1994, estimates were obtained of the amount of game that was caught. The total weight of game captured was 367 kg for all the 94 times that any game was caught. This is a total of 10.39 kg per household that joined in the hunting. Hence, these families had a little less than one kg of game meat per month. Per hunting trip participants obtained an average of 1.3 kg of game.

2.2 Honey

A more worrisome picture appears from the procurement of honey. Honey is a highly appreciated forest resource among the inhabitants of Ngira, Koli and Teriang. It has a cultural importance for many groups in Borneo, and because of it related forest management practice. In West Kalimantan at least four known species of bees yield honey (Graefen and Syafrudin 1994). Except for the main producer of honey in the region, *Apis dorsata*, these species are seldom, and yield only small amounts of honey. Most of the honey is locally consumed, often for medicinal purposes. Some of it may be sold if sufficiently quantities are available. The honey, if available at all, is mostly harvested during the end of the flowering season when *Apis dorsata* bees come to the region, mostly from December through January. Mid year flower seasons may occur and also attract bees. Honey trees or *sompuat* are owned and often carefully kept. The trees themselves are protected by a set of *adat* rules, or customary laws (see also Chapter Eight).

In 1993 and 1994 information was collected on the harvesting of honey, and the ownership of *sompuat* in Ngira. A total of 54% of the village inhabitants did own one or more *sompuat*. The average number of trees owned was 8.46 per person. *Sompuat* often may be owned by more than one person. The data on ownership was not checked for shared ownership. The total number of *sompuat* trees may be less than the total of 228 trees that were reported, as some may have been reported by more than one person

In 1994, a total of 52% of the village households collected honey, while the amount obtained per family that collected honey was 5.17 liter. The year before that only 6% of the families reported to have collected any honey, with a catch of 2.6 liter per collection. In 1993, people were asked when it was the last time that they had gotten any honey in previous years, and how much they collected that time. These results are also presented in Table 4.2. It appears that some of the people only had harvested honey more than a decade ago.

Table 4.2 History of honey collection in Ngira before 1993

Reported last time that honey was collected	% of families reported	Average yield per collection (liters)
1992	4%	7.5
1991	14%	5.7
1990	20%	4.3
1989	8%	13.0
1987	2%	5.0
1981	2%	1.0
1980	2%	1.0
1979	2%	10.0

2.3 Rattan

A forest resource from the island of Borneo which has a reknown economic importance is rattan. This forest commodity has been exploited in Southeast Asian forests since very long (Chapter Three; Belcher *et al.* 2000). In the existing statistics it figures as the most important forest product, next to timber. In Noyan people know a total of 30 rattan species, while 50 species have been reported from the whole of central West Kalimantan.

Rattans are still quite common in Noyan and Jangkang and surrounding areas. Rattan species occur in all types of forests in the area, but are most prominent in disturbed *kerangas* forests, that grows on wide podzolic soils, and in forest groing in peat swamps (Ramon 1993). Rattans are also common in *tembawang* and even occur in swidden fallows (Graefen and Syafrudin 1994). The cultivation of rattans is not as common as in East Kalimantan.

The international demand of rattans is still increasing, and prices have developed favourably. Pontianak based manufacturers apparently obtain much of their raw material from Central and East Kalimantan, rather than from their own province. There is, however, some rattan trade in West Kalimantan. In 1989, 670 tons of rattan were traded. This dropped to 245 tons in 1991 (Graefen and Syafrudin 1994.) Prices paid for first quality rattan reached Rp 700/kg in Ketapang (about US$ 0.35 at that time), south of Pontianak. Reportedly in neighboring sub-district Bonti prices reached 500 to 600 Rp/kg. Despite these market opportunities, no unprocessed rattan was sold from Noyan and Jangkang during the years of research. Some local trading of manufactured products, like baskets or rice threshing mats was common. The data presented in Table 4.3 demonstrate the broad consumption of different rattans. Except for *Calamus caesius*, all these rattans are native to the local forest.

Table 4.3 Number of stems harvested of rattan species in Ngira 1993 and 1994 and Koli 1994

Rattan species (common names)	Ngira 1993	Ngira 1994	Koli 1994
Buo			1
Buda	72		
Jelapa			20
Jirona	45	68	
Juah			12
Kapua	17		
Kuladat	106	2	
Lowo (Korsthalsia echinometra)	188	378	45
Peruntat	15		
Purut (Calamus javensis)		199	
Radi		39	
Rodis	92	117	
Roi	3		
Rona		5	
Rowa			5
Suguh	70	140	68
Unknown		72	
Total	608	1020	151

3. THE NEW PLETHORA OF FOREST PRODUCTS

The useful species harvested by forest managers in the several research villages are distinguished in four different categories of "used" species: (1) Domesticated species, or species that are planted but do not occur spontaneously in the natural forest. (2) Species found in the natural forest, but that are sometimes planted by local farmers. (3) Species that are not planted, but which may be actively tended if they occur spontaneously in rubber gardens, *tembawang* or managed natural forests. (4) Species that only occur spontaneously but are not purposively tended.

The five *tembawang* studied had an average number of 17 (Table 4.4) planted domesticated species. The number of planted forest species averaged 13.6, only slightly lower than the average number of domesticated species. That such species indeed do occur in the forest is proven by the presence of an average of 15 species of this category in the managed natural forest plots. It should also be noticed that some of the domesticated species occurred in the managed natural forest plots. Those species very well may have been planted there when fruits were consumed during visits. It is common that in such situation seeds are planted, and not just disposed of.

Noteworthy is also the large number of the naturally occurring species that are tended (Table 4.4). The total number of species reportedly to be tended sometimes is more than twice as large as the total number of domesticated and planted forest species. In each of the *tembawang*, the number of tended species exceeded the number of planted species. The data presented, however, give a strong indication that *tembawang* are much more than just planted fruit orchards. They are managed forests which are enriched with planted species, but in which a much larger number of useful forest species are being produced.

Table 4.4 Cultivation status of species in tembawang, pulau rimba, and hutan tutupan*

	Total	**Tm1**	**Tm2**	**Tm3**	**Tm4**	**Tm5**	**PR1**	**PR2**	**HT1**	**HT2**
Domesticated	33	15	17	19	12	22	3	1	1	3
Planted forest species	32	12	13	12	11	20	12	18	15	15
Tended forest species	124	33	22	52	39	35	60	57	46	52
Total species	441	91	70	149	105	108	172	180	150	152

* Plots Tm 1-5, tembabwang Ngira. Plots PR 1, 2 pulau rimba in Ngira, plots HT 1, 2 hutan tutupan in Teriang

All the 630 species found in the surveyed forests were divided into 29 different use purpose categories (Table 4.5). Seven categories include uses as an edible product (edible fruits, flowers, leaves, seeds, palmheart, sago an sugar yielding). Four categories specify the use of chemical components of the species (fish poison, medicinal, pesticide, and stimulant). The next groups included uses in the sphere of handicraft manufacturing (dye, handicraft, tie stuff, used to make traps in the forest, utensils), uses for house construction (bark used as walling, wood used to make shingles, leaves used for thatching, and timber), and uses of species as standing trees (hunting site during fruiting season, honey tree, support tree). The last group included a mixture of rest uses (latex used as glue to catch birds, damar yielding, used for magical purposes, harvested for other marketable products, firewood, and other uses not yet mentioned).

Of the 630 species which were recorded during the forest inventories, a total of 575 (91%) had one or more reported use. One single species, *mania* (*Arenga sacchifera*, sugar palm) had seven different uses. It is reportedly used to make sugar, it has edible fruits, the stem is used for flooring and also yields starch. Its shoots can be eaten as vegetables. The hairy spines of the stem are used to make brooms and fish traps, and the leaves are used for decoration in healing ceremonies and for the rice harvesting feast. Three other species had six uses e.g. *juah* (*Shorea* sp.) *kurumi* (*Macaranga* sp.) and *subu* (*Dactynocladus stenostachys*). Most of the species had two (191 species), or one (268 species) uses. The most common uses of all the species recorded were construction (211 species), edible fruits (185 species), firewood (155 species, but probably underreported) medicinals (94 species), and edible leaves (60 species).

Table 4.5 Use categories of species in tembawang (pl 1-5) and pulau rimba (pl 6, 7) in Ngira, and hutan tutupan in Teriang (pl 8,9)

	Total	**Tm1**	**Tm2**	**Tm3**	**Tm4**	**Tm5**	**PR1**	**PR2**	**HT1**	**HT2**
Total species with use	575	144	188	208	154	174	230	237	197	207
Bark	23	2	3	6	2	4	11	15	9	8
Construction	211	55	41	83	62	58	103	100	76	88
Yields damar	3	2	1	3	1	1	3	3	1	2
Used for dye	10	6	4	6	4	8	4	4	4	7
Firewood	155	50	40	74	54	50	70	66	61	62
Edible flowers	2	0	0	1	0	1	0	0	0	0
Fish poison	5	0	0	1	1	0	5	3	2	2
Edible fruit	185	50	48	82	50	81	70	72	69	71
Handicraft	29	5	6	10	6	5	13	12	5	8
Hunting site	60	13	7	19	21	15	29	27	21	29
Yields honey	9	4	1	3	3	2	5	5	1	4
Latex used to catch birds	22	8	7	9	10	11	8	9	8	11
Edible leaves	60	21	23	29	24	26	11	11	15	16
Magical use	16	7	4	5	7	9	6	7	5	6
Medicinal	94	25	22	40	22	29	23	32	24	33
Miscellaneous	36	14	12	17	13	19	11	12	7	12
Marketable	7	5	5	5	4	5	0	3	0	0
Used as pesticide	2	2	1	2	1	1	1	1	1	1
Palm heart	2	0	1	1	1	1	0	1	1	1
Sago	3	1	2	3	2	2	0	0	1	1
Edible seed	25	12	14	18	14	17	6	7	5	10
Used for shingles	4	2	2	3	2	3	2	3	1	1
Support tree	2	1	1	2	2	1	1	1	1	1
Stimulant	11	4	2	3	4	5	4	5	5	3
Sugar producer	1	1	1	1	1	1	0	0	0	0
Thatch	5	1	2	2	3	2	2	2	1	1
Used to make traps	6	2	3	5	3	3	3	3	5	4
Tie stuff	24	9	7	10	8	6	10	10	8	10
Utensils	55	14	16	24	22	21	18	24	22	22

Tembawang and managed natural forests differ in the composition of useful species. *Tembawang* had an average of 160 species with a reported use, and managed natural forests had 218 such species. The number of species with edible fruits was slightly lower in *tembawang* (average 62) than in managed natural forests (average 71) species. In three of the five *tembawang* the number of species with edible fruits was about 30% lower than in the managed natural forests. The variation in number of species with edible fruits in *tembawang* is fairly consistent with the variation in total number of species found in both forest types. The larger number of species with edible fruits in *tembawang* 3 and 5 are a consequence of the larger number of naturally occurring forest species with edible fruits.

There were almost twice as many species with edible leaves in the five *tembawang* (average 25 species) than in managed natural forests (average 13 species) and twice as many species with edible seeds (average 15 *tembawang*, 7 managed natural forests). This phenomenon correctly indicates that most species with edible seeds and many with edible leaves are planted or tended in *tembawang* (Table 4.5).

Table 4.6 Cross tabulation cultivation status and use category all species with use from managed forests

Use category	Cultivated	Planted forest sp.	Tended sp.	Forest sp.
Total species with use	33	32	124	441
Bark	0	1	6	16
Construction	12	12	72	115
Yields damar	0	1	1	1
Used for dye	1	4	2	3
Firewood	11	10	43	91
Edible flowers	0	0	1	1
Fish poison	0	0	1	4
Edible fruits	21	26	55	83
Handicraft	2	0	10	17
Hunting site	2	2	17	39
Honey tree	0	0	9	0
Latex used to catch birds	3	3	4	12
Edible leaves	13	5	10	32
Magic	1	2	1	12
Medicinal	7	8	12	67
Miscellaneous	11	1	2	22
Marketable	3	2	2	0
Pesticides	1	0	1	0
Palm heart	0	0	1	1
Sago	2	0	0	1
Edible seeds	10	5	7	3
Used for shingles	0	1	0	3
Support tree	0	0	2	0
Stimulant	1	2	2	6
Sugar yielding	1	0	0	0
Thatching	1	0	0	4
Used to make traps	0	0	0	6
Tie stuff	1	0	3	20
Utensils	5	1	10	39

There is very little difference in densities of species used for medicinal purposes between the *tembawang* (average 28 species) and managed natural forests (average 28 species). The highest number of species with medicinal use were, in fact, found in *tembawang* No 3 (40 medicinal species). Considerable difference could be noticed in the number of species which are used for timber, and from which the bark can be used for walling. The five *tembawang* had an average of 70 species which are used for timber, whereas this number was 92 in the managed natural forests. In the two *pulau rimba* forests there were 103 and 100 timber species present, respectively. This difference does, however, not mean that timber species are not managed in *tembawang*. Table 4.6 shows that almost half of all timber species that occur in the inventories are sometimes tended. Although many of those timber species are grown because they also have other uses, there were at least 29 species that were planted or tended principally for its use as construction wood. Tending of timber species only occurs in *tembawang*, not in natural forests.

4. ECONOMIC RETURNS FROM MANAGED FORESTS

The three types of managed forests compared here: *tembawang*, *pulau rimba* and *hutan tutupan* show a few clear differences in terms of economic returns. Appendices 4.1 through 4.3 provide summaries of the produce obtained from three different types of managed forests. The *tembawang* displayed the largest variation of products, including quite a few cultivated tree species like rubber trees and bamboos. Chapter Six discusses the role of rubber in the evolution of management of *tembawang*. *Tembawang* yield more fruits, edibles, and various items used for the manufacturing of household materials than *pulau rimba* and *hutan tutupan*. This specialisation makes sense, as these forests are located at not too far a distance from the village centre. The only exception to this general rule is the collection of edible leaves and of medicinal plants which more often appears to be harvested from natural forests.

Another fact related to the kind of products harvested from *tembawang* is the frequency with which these are visited. This is much more often than in other managed forests. In one case, the owner reported that some member from the family visited one particular *tembawang* pretty much every single day of the week. Although this may be an exceptional case, and partly relate to the presence of bamboo shoots and ferns, it does indicate a principally different role of *tembawang* in people's livelihoods, compared to managed natural forest types.

Pulau rimba forests are visited mainly to collect rattans, poles and wild fruits, when they are available (Appendix 4.2). So far little timber has been harvested from any of the *pulau rimba* while this already has happened in several *tembawang*. On the contrast, many owners of *pulau rimba* stated that they kept their forest as a source for timber. Although this could possibly be a strategy to conserve timber resources in privately owned forest reserves, it may also be that simply the timber stock closer at home has been consumed first.

The *hututan tutupan* appeared slightly in between *tembawang* and *pulau rimba* in terms of the number and amounts of products that were harvested in these forests. The number of products harvested from the *hutan tutupan* was similar to that reported from the *tembawang*. The communal forest researched supplied timber, especially ironwood, rattan, edible leaves and medicinal plants (Appendix 4.3). The forest also yielded a number of fruit species, several of which have been planted, although it is not clear for all the species who did this planting. Planting in natural forests is a common phenomenon among Dayak forest managers, and in some instances *tembawang* may actually be created in full grown forest, rather that in a swidden field, as is more common (See Chapter Six).

It is very variable how often people visit *hutuan tutupan*. In the forest in Teriang, two trails that lead to principal swidden areas pass along the East and the West side, and they partly lead through the forest. Often people may just pick up things on their way to, or back from the swidden. Some people reported they had not specifically gone to the forest at all during the last year. Others reported up to 20 visits in a single year.

The economic importance of *tembawang*, *pulau rimba*, and also *hutan tutupan* has to be extrapolated from data on direct economic returns, and from inventories of use value of species. Although the average number of useful species in managed natural forests is higher than in *tembawang*, both the data on cultivation status and on economic returns indicate that the latter supply more products to their owners than *pulau rimba* do. This is no surprise because that's what *tembawang* are created for.

5. ADAPTIVE FOREST MANAGEMENT IN CHANGING ECONOMIES

The evidence of the previous sections suggest a complicated picture of on the one hand a declining availability of a number of important resources that used to be collected from among others natural forests. Especially game and honey are two products that are becoming in short supply. This is primarily to be attributed to a decreasing forest base that allow both mammals and honey bees to survive in the region. This decline, however, is not yet solved with a widespread replacement of FP or other natural products with products bought in markets.

The data above do suggest a contradiction in this respect that has puzzled researchers before. The inventories of the different types of managed forests yield a total of 575 species that have a reported use value. The data on the cultivation status showed that 33% of all these species are either planted or tended. Yet owners of *tembawang* reported only to actually have harvested between 11 and 18 species, or about 7 to 12 % of the species with a recorded use purpose. These numbers were even lower for the managed natural forests.

However we do not believe this to be a change in preference by the forest managers. Virtually all swidden agriculturists in West Kalimantan now participate to some degree in a cash economy, and the inhabitants of the villages where forest management was studied now also consume an important number of products that are manufactured elsewhere. However, the average income among the people in the researched villages is still quite low, and does not allow an increased consumption of products obtained through cash-exchange. A better explanation of the phenomenon pointed out in this paragraph may be a fairly high substitutability of products though consumption of different species, or alternatively a fairly large degree of immature individuals of the useful species in the forests studies here.

Probably more indicative of the responses to the changing supply of forest resources are the overall patterns of forest management. The data above suggest an active maintaining of several types of managed forests to assure a supply of FP that still can widely be used in daily subsistence. In addition, forests like *tembawang* are managed such as to increasingly supply a wider suite of products. These are all actions that suggest responses to sustain supply of FP that are recognised to be important in daily subsistence.

Lastly, an import indication is the changing perceptions and attitudes towards *pulau rimba*. These forest in the old days used to be held more as a forest reserve for future use as swidden site, rather than a forest resources. This has changed over the last years, especially in one village, Ngira. *Pulaut rimba* are now increasingly kept for their supply of FP, and this is reflected in an increased claim of the private property status of these forests. This is, for instance, also reflected in the practice of tree planting in those forests, including rubber trees. Beside enhancing the returns from those forests, these practices clearly are meant to assure private property claims over the forest itself.

APPENDIX 4.1 ECONOMIC RETURNS FROM 4 FOREST GARDENS (*TEMBAWANG*)

The owner from ***tembawang* 1** reported to harvest 1kg of rubber 60 days per year. Also three times per week one basket of edible *pikat* leaves (no identification) is harvested, while twice per week firewood is collected. Once per year 3 stems of *munti* (bambu with a big stem), and some bamboo shoots are harvested. *Suguh* (*Calamus caesius*) yields only 2 stems/year. Twice per year, during the rice harvest feast and during rice planting season, about 200 leaves of *daut rayo* are collected (a Maranthaceae which is harvested for its leaves, used to wrap food). Fruits which are harvested once a year are *mpoya* (no identification) which yields 20-30 fruits each month of July, *dumpei*, and *buliti* (both *Nephelium* spp). Other trees only fruit once every three to five years. In 1993, 200 durian fruits were harvested. *Rona* (a wild durian) yields about 50 fruits when it produces. *Ntowo* (*Artocarpus anysophyllus*) yields 100 fruits every 5 years. *Tangan susu*, (a planted liana from the forest, possibly a Sapotaceae) yields 200 fruits when it produces. *Buronte* (no identification) yields 10 kg of fruits, and *sukuap* (no identification) 1kg of fruits every fruiting season. *Ramei* (a wild rambutan), and *concot* (*Baccaurea* sp., a wild tampui) yield once every three to five years. Already 8 ironwood trees, 2 *bayuar* (*Pterospermum sp.*) trees, and 1 *juah* (*Shorea* sp.) tree were harvested for house construction. This means that, except for the firewood, a total of 18 species were reported to have been harvested. The respondent visits the *tembawang* several times per week, and about once per week some slashweeding is carried out to deliberate tended species.

***Tembawang* 2,** of the same owner as the previous one, reportedly yields 2kg rubber per day for 60 days per year. Edible ferns and bamboo shoots are harvested almost every day. *Mpoya* yields 20-30 fruits per year, *puruntuat* (*Artocarpus* sp.) 50 fruits per year, and *jorit* (*Phitecellobium* sp.) 10 kg every year. *Dumpei* and *buliti*, and *ramei* (rambutans) are harvested each year. *Daut soberiet* (a different Maranthaceae species used for its leaves) is also harvested twice a year each time 2 bundles of 200 leaves. Twice a year *suguh* rattan is harvested, 6 stem of 50 m each time. 20 bambu stems, used for flooring in the *pondok*, the temporarily house in the swidden, and 10 stems, used for make rubber recipients, are harvested from this field. One sago stem per year is harvested for its edible starch, and 20 sago leaves are harvested for thatching the pondok. *Ntowo* yields about 40 fruits about every 5 years, and *tengkawang* or illipe nut (*Shorea* sp.) yields about 200 kg each fruiting season, of which there was one in 1982 and 1988. 13 ironwood trees have been harvested. 1 times per month firewood is collected. The total number of species harvested from this second *tembawang*, except for firewood, is 14. On average, this *tembawang* is visited once per week by members of the owner's household to harvest something, and about during every visit some clearing is carried out as well.

The owner of ***tembawang* 3** could only provide scarce information about economic returns. Rubber is harvested from this field, and fruits when there are. *Puruntat* (*Artocarpus* sp.) and *rona* (wild durian) are species which apparently are harvested frequently. Sometimes honey is collected, and 10 ironwood trees have been harvested.

From ***tembawang* 4** rubber has been harvested since 1971. In earlier years up to 7 kg per day could be harvested, but this is now only 2.5 kg per day. Several times per week *pokuh ntowo*, or *pokuh rayo*, two edible ferns, and bamboo shoots are harvested. *Daut rayo* is harvested twice a year. *Kaja* (a Monocotyledonae, no identification) is collected once a year to make mats. *Buliti* (wild rambutan) yields about 1000 kg of fruits every year, and *puruntat* (*Artocarpus* sp.) 200kg of fruits per year. *Tengkawang* (*Shorea sp.*) was harvested from two trees in 1968, 1971, 1976, 1981, 1987, and 1988. Five ironwood trees were harvested. One nest of honey was harvested from a *tapa* (*Koompassia excelsa*) tree, the last time in 1989. Firewood is collected from this field almost every day. A total of 11 species, except the firewood, were reported to be harvested from this field. The owner spends about 5-6 days per year, each time from morning until midday on slash-weeding the surroundings of the trees that are harvested.

APPENDIX 4.2 ECONOMIC RETURNS FROM 2 PRIVATE FOREST RESERVES (*PULAU RIMBA*)

The owner of *pulau rimba* 1 obtains most of the rattans he needs from this forests. Species harvested are *gogap*, *pese*, *rauh*, and *lowo* (no identification). Also roundwood and *bacok* leaves are harvested for thatching the hut in the rice field. Only 5 species harvested were reported by name. The roundwood used to make the hut in the rice field was not specified. The owner makes irregular visits to this *pulau rimba*. If some materials are needed, than within a single week three to four trips may be made to this forest.

The owner of the *pulau rimba* 2 harvests roundwood and *bacok* leaves for the pondok from this field. Rattans: *lowo*, *lowo nun, baruh*, rattan *kuladat*, *umki manis*, and *puruwat* (no identifications) are harvested to make baskets, to construct the pondok, and for other purposes. There are three harvestable trees of *romuan*, a wild rambutan, which are harvested once every several years and than yield about three to four large baskets. One *manta* (*Xanthophyllum* sp.) tree yields two to three large baskets whenever it fruits. *Ntowo* fruits, *tampui* (*Baccaurea* sp.) fruits, *buda* fruits, *potei* (*Parkia singularis*) fruits, *nubua* (Arecaceae) for its palm heart, *sukuap* for its fruits, and *rusup* (no identification) and *kuraci* (*Lithocarpus* sp.) for its edible seeds are harvested. A total of 17 species were reported to be harvested from this private forest reserve. Until now, not any large timber tree was harvested. If there is no fruiting season the owner goes maybe three to four times per year to this field, one of which specifically to harvest rattans. His wife, however, goes about once per months to look for rattans. In years with fruits, the number of visits to the forest reserve forests increases.

APPENDIX 4.3 ECONOMIC RETURNS FROM COMMUNAL FOREST RESERVES (*HUTAN TUTUPAN*)

The *hutan tutupan* on Teriang mountain is protected principally as the most important source of ironwood, not only for people from the village, but also for people from nearby places. In addition to villagers the ironwood tree is also harvested every year by about 10 to 15 people who are not from Teriang. Furthermore, inhabitants of the village sell shingles to nearby villages. Other timber species which people reportedly harvested from Teriang mountain are *pongo bioa* and *juah* (both *Shorea* sp.), used to make planks and beams for local house construction. The forest on Teriang mountain is also a source of many other products. It contains nine mature *puruntat* trees, 28 *durian* trees, five *ntowo* trees, one *tengkawang* (*Shorea* sp.) tree, and five *kawei* trees (*Durio kutejensis)*. These trees are communally owned; if one of these trees yields, a group of representatives of each family of the village goes out to collect the fruits together with the village head, who divides them among those who come along.

Several informants reported that they also harvested fruits of *buda, ntowo* (both *Artocarpus* spp*), moyu* (*Dacryodes rostrata*)*, lok* (*Alangium ebenaceum*), *bomat, nayu, tungka, ntolang*, and *sumpa tajo* (no identification) on an individual basis. People harvest edible leaves like *kantuat, tabiet, supa*, and *puruh* (no identifications). The most common rattans harvested are *puruat, jolai, onka kolait,* and *lowo* (no identification). Also many people of Teriang reported they often collected medicinals from the *hutan tutupan*. The total number of species reported to be harvested was 23, not including medicinal plants; 40 species found on Teriang mountain were reported to be used for medicinal purposes.

APPENDIX 4.4 LIST OF SPECIES ENCOUNTERED IN INVENTORIES OF MANAGED FORESTS IN NGIRA, KOLI AND TERIANG THEIR RECORDED USE, CULTIVATION STATUS AND NATURAL HABITAT (FOR CODES USED, SEE END OF THIS TABLE).

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
Acanthaceae	Cosmianthemum	514	uri mpuah	Md	Fo	PO
	Ptyssiglottis	300	motia	Lv	Fo	TO
	Staurogyne setigera (Nees.) O.K.	728	ngkala njenjum	Md	Fo	PO
		344	daut ngkuduap			
Actinaceae	Saurauia	496	ribodua	Fr,Fi	Fo	TO
	Saurauia	302	ribonsik	Md	Fo	TO
Alangiaceae	Alangium ebenaceum		lok	Fr,Cs	Td	BO
Amaryllidaceae	Curculigo orchioides Gaertn	697	rumo	Fr,Ts,Lv	Fo	BO
	Curculigo latifolia Dryand	490	suup	Fr	Fo	PO
Anacardiaceae	Mangifera		maca	Fr	Td	TO
	Pentaspadon motleyi Hook. f.	535	puroju	Fr,Cs	Fo	TO
	Smecarpus glaucus Engl.	747	compo		Fo	TO
	Smecarpus glaucus Engl.	777	kugadik	Cs	Fo	PO
	Smecarpus	660	motuh mpuni	Cs,Hs	Fo	PO
Annonaceae	Annona	476	nangkok	Fr,Sd,Lt,Fi	Pl	TO
	Cananga odorata	622	tinuah	Ts,Cs	Fo	TO
	Cyathocalyx	515	mubei	Tr,Cs,Hc,Ts	Fo	BO
	Cyathocalyx	429	nontat	Cs,Bk	Fo	PO
	Disepalum	666	nae	Cs	Fo	BO
	Goniothalamus	348	jujua gontu			
	Goniothalamus	415	nae	Cs	Fo	BO
	Goniothalamus	335	tubuh muan	Ma	Fo	BO
	Monocarpia	423	nae	Cs	Fo	BO
	Orophea hexandra Bl.	727	nae motuh	Md	Fo	PO
	Polyalthia rumphii	544	jujua gontu			
	Polyalthia sumatrana	416	nae	Cs	Fo	BO
	Polyalthia beccarii King	667	nae	Cs	Fo	BO
	Polyalthia cauliflora Hook.et Th.	729	ngoruap		Fo	TO
	Polyalthia	504	tubuh bojik	Cs	Fo	PO
	Pseuduvaria	538	kungorup	Ut,Fi	Fo	BO
	Xylopia	468	ngirat	Cs,Fi	Fo	PO
	Xylopia	439	ngkurari	Cs,Fi	Fo	PO
	Xylopia elliptica Maing	765	ngkurari gomi	Cs,Fi	Fo	PO
Apocynaceae	Tabernaemontana	400	nganga	Lt,Mi,Pc,Fi	Td	BO
	Tabernaemontana macrocarpa	399	nganga	Lt,Mi,Pc,Fi	Td	BO
	Alstonia angustifolia Wall. ex A.DC	767	kuticiat			
	Chilocarpus enervis Hook. f.		tangan jadat	Fr	PF	PO
	?	444	tangan susu	Fr,Lt	PF	PO
Aquifolariceae	Ilex	375	adit bowo	Cs	Td	PO
	Ilex	516	marou	Hc,Ut	Fo	
Araceae	Alocasia	634	kuladi	Lv	Fo	TO
	Amydrium	536	kurakas akar			
	Anglaonema simplex Blume	779	bunuh muan	Md	Fo	BO
	Anglaonema	333	kuladi	Lv	Fo	TO
	Caryota	351	sompuar	Ph,Ut,Sa,Mi	Fo	TO
	Daemonorops	451	mpua			
	Homalonema	352	tungun	Md,Ma	Fo	TO
	Homalonema	376	tungun sio			
	Licuala	432	biro	Th	Fo	BO
	Licuala	319	biro	Th	Fo	BO
	Piptospatha	358	pikat kancik		Fo	BO_
	Pothos	641	ngkala botuh	Md	Fo	
	Pothos	367	timpak boju			
	Rhaphidophora	599	kurapas		Fo	BO
	Schismatoglottis	353	pikat	Lv,Hs	PF	TO
	?	521	bakok	Th	Fo	PO
	?	604	podis	Ut,Sh	Fo	BO
	?	412	rauk		Fo	PO
	?	614	sabuat	Hc,Fr	Fo	
	?	601	tapah	Hc	Fo	
	?	377	tingkas			
Aralaceae	Aralidium pinnafitidum	576	palis	Md	Fo	BO
Arecaceae	Areca	354	pina babu		Fo	BO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
	Calamus	418	jumput	Hc	Fo	PO
	Calamus	801	ntai	Hc,Ts	Fo	PO
	Calamus	520	panok	Mi	Fo	BO
	Calamus (no label)	612	puruwat			
	Calamus	450	roih			
	Calamus	505	suguh	Fr,Hc	Fo	BO
	Cocos nucifera		buntat	Fr,Mi,Lv,Ut	Pl	TO
	Korthalsia	543	lowo nun	Hc	Td	BO
	?		bareh	Hc,Ts,Cs,Ut,Sa	Pl	TO
	?	661	danan	Ts,Hc,Mi	Fo	TO
	?		nubua	Ph,Ut,Cs	Td	PO
	?	708	pina baja	Ut,St	Fo	
	?	665	sorikois	Fr	Fo	PO
Asclepiadaceae	Hoya	564	njadat	Lt	Fo	BO
	Tylophora perlaxa Schltr.	753	gurubua babei			
	Tylophora perlaxa Schltr	736	inju tono			
	Tylophora perlaxa Schltr.	752	kobual			
Asplenium Group	Asplenium acutiusculum Bl.	698	poku asir		Fo	TO
Asteraceae	Adenostema	365	daut kopik tumua	Md	Fo	TO
	Agreratum conyzoides	304	jiroja komik	Md	Fo	TO
	Blumea	460	suah			
	Mikani cordata	362	jeriti			
	Vernonia arborea	471	mampuat	Cs,Fi	Fo	TO
Athyrium Group	Diplazium esculentum	702	poku	Lv	Fo	TO
Auraliaceae	Schefflera	441	songup			
Bambuseae	?		putua	Cs,Mi	Pl	PO
Begonae	Begonia	339	kuru	Lv	Td	TO
Blechnum Group	Blechnum orientale L.	700	poku usuh	Lv	Fo	BO
	Stenochlaena palustris	597	cokas	Hs,Cs	Fo	BO
Bombacaceae	Ceiba pentandra (L.) Gaertn.	759	kabu	Mi,Sd,Cs	Pl	TO
	Durio zibethinus L.		diat	Fr,Sd,Cs,Md	Pl	TO
	Durio	648	diat manua	Cs,Hs	Td	BO
	Durio kuteyensis (Hassk.) Becc	394	kawei	Fr,Cs	Pl	TO
	Durio		kemanik	Cs	Fo	
	Durio excelsus (Korth.) Bakh	764	kurojiat	Fr,Ut,Cs	Td	BO
	Durio	395	rona	Fr,Cs	Td	TO
Burseraceae	Dacryodes rostrata		moyu	Fr,Fi,Da	PF	BO
	Dacryodes rugosa H.J. Lam	446	moyu tajuk	Fr	Fo	BO
	Santiria oblinifolia Bl.	695	gurama boncik	Cs,Hs	Fo	PO
	Santiria apiculata Benn. var. apiculata	507	poriat su	Fr,Fi	PF	BO
Clusiaceae	Garcinia nigrolineata Planch. ex T. Anders	783	kucubat	Fr,Fi	Fo	BO
Combreataceae	Combretum	561	kugarap	Dy	Fo	BO
	Terminalia	479	munut	Cs,Fi	Fo	TO
Commelinaceae	Forrestia mollissima (Bl.) Kds.	743	balosat manias			
	Forrestia mollissima (Bl.) Kds.		bulosat manias	Md	Fo	TO
Connaraceae	Angelaea insignis Leenh	528	kubodu	Ts	Fo	BO
	Angelaea borneensis (Hook.f.) Merr	668	kungorup akar	Hc,Tr	Fo	BO
	Cnestis (Sterile)	541	jukat coku	Md	Fo	PO
Convolvulaceae	Merremia peltata (L.) Merr	676	mukau	Lv,Ts	Fo	
Convulvulaceae	Erycibe	403	moda rungkik	Cs,Ut,Hs	Td	BO
Cornaraceae	Mastixia rostrata Bl.	751	rimadit	Ut	Fo	BO
Cucurbitaceae	Momordica	363				
Cyperaceae	Cyperus kyllingia Endl.	690	iduh kamok		Fo	TO
	Scleria	434	monua			
Daphnaceae	Daphniphyllum	510	moda ludua	Cs,Ut	Td	PO
Dilleniaceae	Dillenia	646	dangin	Mi,Md	Pl	BO
	Dillenia	406	dangin tuat	Fi	Fo	BO
	Tetracera	526	mpolas tas	Mi	Fo	BO
Dioscoreaceae	Dioscorea	592	jalokois	Hs,Ts	Fo	TO
Dipterocarpaceae	Hopea dyeri		amang	Cs,Bk	Fo	PO
	Hopea		amang bosi	Cs,Bk	Fo	PO
	Hopea		amang jangkar	Cs,Bk	Fo	
	Hopea		amang kurongas	Cs,Bk	Fo	PO
	Hopea		amang njomo	Cs,Bk	Fo	PO
	Hopea	466	amang podi	Cs,Bk	Fo	PO
	Hopea		amang turu	Cs,Bk	Td	BO
	Hopea sangal		tokap	Cs,Hs	Td	PO
	Hopea		tokap bintat	Cs,Hs	Td	PO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
	Shorea		damar toncua	Cs,Bk	Fo	PO
	Shorea	548	juah	Cs,Fi,Bk,Md,Hs,	Td	BO
	Shorea		juah bayar	Cs,Fi	Td	PO
	Shorea		juah bosi	Cs,Fi	Td	PO
	Shorea		juah bui	Cs,Fi	Td	PO
	Shorea		juah buruh	Cs,Fi	Td	PO
	Shorea		juah diat	Cs,Fi	Td	PO
	Shorea		juah jorat	Cs,Fi	Td	PO
	Shorea		juah kunian	Cs,Fi	Td	PO
	Shorea rugosa Hiem	725	juah monga	Cs,Fi	Td	PO
	Shorea		kuladat bona	Cs,Hs	Fo	PO
	Shorea		kuladat bululua	Cs,Hs	Fo	PO
	Shorea laevitifolia		kuladat rimingkei	Cs,Hs	Fo	PO
	Shorea		majou	Cs,Mi,Mk	Td	BO
	Shorea macrophylla		ngkawa	Mi,Cs,Ut,Hs,Mk	Pl	TO
	Shorea mecystopteryx	537	ngkawa layar	Cs,Hs,Mk	PF	PO
	Shorea		ngkawa rua diat	Cs,Hs	Fo	PO
	Shorea macrophylla	563	ngkawa tukul			
	Shorea seminis	617	sirina	Cs,Mk	Td	TO
	Vatica	540	kamok	Lt,Ut	Fo	BO
	?		rosa	Cs,Fi,Sh	Fo	TO
Ebenaceae	Diospyros	607	brahun	Fi	Fo	TO
	Diospyros auren T. et. B	773	kungorup	Ut,Fi	Fo	BO
Elaeocarpaceae	Elaeocarpus	472	comuk	Fr,Cs,Hs		PO
	Elaeocarpus brevipes Merr.	718	gomi bua	St,Md,Fi	Td	BO
	Elaeocarpus stipularis	485	panse	Cs,Fr,Mi,Hs,Fi	Fo	BO
	Elaeocarpus mutabilis Werbel	673	panse bua	Fr,Fi	Td	TO
Euphorbiaceae	Antidesma leucopodum	463	cingkolik	Fr,Fi,Tr	Fo	BO
	Antidesma	329	kosaumpo	Fi	Fo	BO
	Antidesma tomentosum Bl.	737	kusiro rue	Cs	Fo	PO
	Antidesma tomentosum Blume	791	sompo	Tr,Fi	Fo	TO
	Aporosa alia Schot	402	Kusala		Fo	BO
	Aporosa lucida (Miq.) A.S. var. trilocularis Schot	457	Mas	Ut	Fo	BO
	Baccaurea	343	Bacok	Fr	Fo	BO
	Baccaurea	397	Bora	Fr,Cs,Hs	Fo	BO
	Baccaurea	341	Concot	Fr	Td	BO
	Baccaurea	389	Gulomik	Fr,Lv,Md	PF	BO
	Baccaurea		Kurap	Fr,Cs	Fo	PO
	Baccaurea	340	Ramei	Fr,Lv,Sd,Cs	Pl	TO
	Baccaurea griffithii	396	Tampui	Cs,Fr,Bk,Dy	PF	BO
	Baccaurea	390	Tungka	Fr,Cs,Fi	PF	BO
	Breynia racemosa M.A.	757	tabiat kurocap	Fr,Lv	Fo	TO
	Bridelia monoica (Lour.) Merr.	741	Dampuer		Fo	TO
	Bridelia minutiflora Hk. F	655	Tugek	Fr,Fi	Td	TO
	Claoxylon	321	Supa	Lv	Td	TO
	Cleistanthus	462	bora lauet	Fi	Fo	PO
	Cleistanthus	522	Kumadu	Cs	Fo	BO
	Cleistanthus	531	Uba	Cs,Fi,Fr,Hs	Fo	BO
	Croton tiglium L.	717	kuriat lok	Fi	Fo	PO
	Dimorphocalyx	498	Buronte girek			
	Endospermum	525	Ciro	Cs	Fo	TO
	Fahrenheitia pendula (Hassk.) Airy Shaw	745	ramei borua	Fr	Fo	PO
	Galearia aristifera	436	tankai ajok	Ma	Fo	PO
	Glochidion	372	Njunjum	Cs,Hs	Td	TO
	Glochidion insigne (M.A.) J.J.S.	798	Purayua	Fi	Fo	TO
	Glochidion	430	Sit			
	Macaranga	492	Cias			
	Macaranga pruinosa (Miq.) Merr	356	kobal oma	Mi	Fo	TO
	Macaranga	334	Kura	Ut,Md,Fr,Fi	Fo	BO
	Macaranga veccariana	447	Kura	Ut,Md,Fr,Fi	Fo	BO
	Macaranga	577	Kurumi	Fr,Lv,Sd,Fi,Hs,	Pl	TO
	Macaranga	487	Mobua			
	Macaranga lowii	427	Ngkubak	Fi,Cs	Fo	BO
	Macaranga cf lowii	532	Ngkubak	Fi,Cs	Fo	BO
	Macaranga javanica (Blume) M.A.	795	Pias			
	Mallotus	575	Gowa	Fi	Fo	BO
	Mallotus	467	Mporek	Cs	Td	BO
	Mallotus miquelianus	642	ngkubak	Fi,Cs	Fo	BO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
	Mallotus paniculatus (Lmk.) M.A.	671	rinat	Fi	Fo	_
	Neoscortechinia sumatensis S. Moore	547	posa rimpiu	Cs,Fi,Fr	Fo	BO
	Pimeleodendron griffithianum (M.A.) Bth.	677	pulai	Cs,Ut	Fo	PO
	Pimeleodendron griffithianum (M.A.) Bth.		pulai			
	Sauropus androgynus (L.) Merr.	780	cangkok	Lv,Fr,Md	Pl	TO
	Sebastiania borneensis	545	mamiah	Bk,Cs	Fo	BO
	Sumbaviopsis albicans (Bl.) J.J.S.	391	buronte	Fr,Fi	Pl	TO
	Trigonopleura malayana Hook. f.	445	gomi balua	St,Fi,Md,Cs	Td	PO
	?		kulampei	Fr,Lv,Hs	Fo	TO
Fabaceae	Archidendron fagifolium (Bl.ex Miq.) Nielsen	730	kauwa	Fi	Fo	TO
	Crudia tripicola de Wit	738	borimpirok	Cs	Fo	PO
	Moghania macrophylla (Willd.) O.K.	714	sabak muan jowo	Md,Ma	PF	TO
	Phanera fulva Bl. ex Miq.	678	libama		Fo	BO
	Saraca declinata (Jack) Miq.	796	biou	Ut	Fo	TO
Fagaceae	Castanopsis	594	kuraci barak	Sd,Fi,Cs	Td	BO
	Lithocarpus		kuraci	Sd,Cs,Fi	Td	BO
	Lithocarpus		kuraci bapiat	Sd,Cs,Fi	Td	PO
	Lithocarpus	557	kuraci uou	Sd,Cs,Fi	Td	PO
	Lithocarpus hystric (Korth.) Rehd.	800	kuraji bapiat			
	Lithocarpus clementianus (King. ex H.f.) A.Camus	775	kutumu	Fr,Fi,Cs		BO
	Lithocarpus nieuweenhuisii (V.Seem.) A.Camus	774	mpele podi	Fr,Hs	Fo	PO
	Lithocarpus conocarpus (Oudem.) Rehd.	664	mpele podi	Fr,Hs	Fo	PO
	Lithocarpus sericobalanus E.F. Miq.	709	mpele sowo			
Fern	?		raja	Ma	Fo	BO
Flacourtiaceae	Casearia sp.		tabiat rojo	Lv	Fo	TO
	Casearia	762	tabiet rojo			
	Casearia rulugosa Bl.	686	uri pongua			
	Flacourtia rukam	603	rukap	Fr,Md,Fi	Td	
	Hydnocarpus anomala (Merr.) Sleum	781	kuinju			
	Hydnocarpus gracilis (V.SLoot) Sleum	682	kulapo ciuar	Hs,Cs,Fi	Fo	BO
	Hydnocarpus	524	kusiro rue	Cs	Fo	PO
	Osmelia philippina (Turcz.) Bth	711	koyuh kurongas	Cs	Fo	BO
	Osmelia philippina (Turcz.) Bth.	766	ringkadit	Fi	Fo	PO
	Pangium edule	500	mpoya	Fr,Sd,Pc	Pl	TO
	Ryparosa	453	mpiras	Cs,Fi	Fo	BO
	Ryparosa javanica (Bl.) Kurz ex K.& V.	770	ramei sat	Fr,Fi	Td	BO
Gesneriaceae	Cyrtandra	347	niomanroka	Md	Fo	TO
	Cyrtandra oblongifolia (Bl.) B.&H. ex Clarke	772	pulanua bua	Lv	Fo	PO
	Cyrtandra	323	ribomo	Mi	Fo	BO
	Didymocarpus critina Jack. var. nigrec		kura gobomo	Md	Fo	TO
	Didymocarpus crinita Jac var.nigrecens	776	kurago bomo			
	Didymocarpus	523	rurup mporua	Md	Fo	BO
	Didymocarpus crinita Jack. var. Nigrecens	712	uri midit	Md	Fo	TO
Gnetaceae	Gnetum	424	kuriat	Fr	Fo	TO
	Gnetum gnemon L	659	ponta	Fr,Sd,Lv	Td	BO
	Gnetum	539	tinga	Ts,Hc	Fo	PO
	Dinochloa	627	punti	Md	Fo	
	Imperata cylindrica	478	poda	Ut	Fo	TO
	Miscanthus floridulus (labill.) K.	489	limpiua			
Graminae	Centotheca lappacea (L.) Desv Schum.	371	iduh kupose			_
	Paspalum conjugatum Berg.	370	iduh baduli	Md	Fo	TO
	Schizostachyum	486	munti	Cs,Fi,Ut,Mi	Pl	TO
	?	481	buruh	Ut,Fi	Fo	TO
	?	499	mporek	Cs	Td	BO
	?	494	poringanjang			
	?	480	poyat	Cs,Fi,Ut,Th,Lv	Pl	TO
Guttiferae	Cratoxylum arborescens	509	gurunga	Cs,Sh	Fo	PO
	Garcinia		bunah	Fr,Fi	Fo	TO
	Garcinia	585	konis	Fr,Lv,Fi,Cs,Md	Td	TO
	Garcinia Bancana (Miq.) Miq	683	kucubat bada	Cs,Fr,Fi	Fo	PO
	Garcinia	408	ntururugu	Ut	Fo	PO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
	Garcinia (Sterile)	588	sumpa tajo	Fr,Ut	Fo	BO
	Mammea	461	kukopa			
Icacinaceae	Gomphandra	568	abak mporua	Md	Fo	BO
	Gonocaryum impressinervium Sleum.		lai sangun	Cs	Fo	PO
	Gonocaryum impressinervium Sleum	769	lai sangun			
	Phytocrene racemosa Sleum	758	abak mporua	Md	Fo	BO
Labiatae	Hyptis rhomboidea Mart. & Gal.	688	bulosat bankei	Md	Fo	TO
Lauraceae	Actinodaphne	621	moda jilowat	Cs,Ut,Hs	Td	
	Beilschmiedia	364	moda ngkala	Cs,Ut,Hs	Td	BO
	Dehaasia	640	moda jilowat	Cs,Ut,Hs	Td	
	Endiandra ochracen Kosterm	713	moda babu	Fi	Fo	BO
	Eusideroxylon zwagerii		tas	Cs,Sh,Lv,St	PF	BO
	Lindera lucida (Bl.) Boerl.	706	moda badua			
	Litsea	549	moda ayou	Cs,Hs	Fo	BO
	Litsea	443	moda cabe			PO
	Litsea	643	moda ngkala	Cs,Ut,Hs	Td	BO
	Litsea garciae	623	ngkala	Fr,Lv,Md,Fi,Sd	Pl	TO
	Litsea elliptica Boerl.	754	pulangeia			
	Nothaphoebe umbelliflora Blume	787	njotu ragi	Cs,Fr	Td	TO
Leeaceae	Leea	327	lale	Fi,Ut	Fo	BO
	Leea	305	lale	Fi,Ut	Fo	BO
Leguminosae	Archidendron	591	jorit	Fr,Lv,Mk	Pl	TO
	Archidendron	508	limpete	Fi	Fo	PO
	Bauhinia	631	libama		Fo	BO
	Callerya nieuwenhuisii (J.J.S.) A Schot	306	bulungei	Fr,Ut,Ma	Fo	BO
	Dialium indum L.	421	kuronje madu			
	Fordia splendidissima (Bl. ex. Miq.) Buysen	448	rimponan	Fi	Fo	BO
	Kompassia malaccensis	398	tapa	Ho,Cs	Td	BO
	Mucuna	554	ladik		Fo	TO
	Parkia singularis		potei	Fr,Lv,Cs	Td	TO
Liliaceae	Dracaena agustifolia	413	rasak			
	Smilax zeylanica Lam	771	boit abel	St	Fo	TO
	Smilax	410	ngoda babu		Fo	BO
	Smilax	635	puronga	Lv,Ut	Fo	
Linaceae	Indrourouchera griffithiana	512	pido	Ut	Fo	BO_
Loganaceae	Fagraea racemosa	645	gawa		Fo	
Lygodaceae	Lygodium circinnatum	527	morua	Lv	Fo	TO
Magnoliaceae	Magnolia candollii (Bl.) Keng	519	ponual		Fo	PO
Maranthaceae	Donax canniformis	382	bomat	Hc,Md	Td	TO
	Donax cannaeformis (G.Forst.) K. Schum	792	daut rabu			
	Donax cannaeformis (G.Forst.) K. Schum	799	tato		Fo	BO
	Phrynium	317	daut			
	Phrynium	318	daut suboriah			
	Stachyphrynium	320	pala		Fo	TO
Melastomaceae	Dissochaeta	756	kuru tawa			
	Macrolenes	552	radis	Ts	Fo	PO
	Marumia setosa ohwi	749	uri njomun			
	Medinilla	458	kuru kunciet			
	Melastoma malabathricum	435	risa	Fr,Ut	Fo	TO
	Memecylon	632	mas nturu	Ut	Fo	PO
	Memecylon edule Roxb	670	uba	Cs,Fi,Fr,Hs	Fo	BO
	Pachycentria	431	sonik			
	Pternandra	624	suku	Ut	Fo	
Meliaceae	Aglaia	311	kusorei	Fr	Fo	BO
	Chisocheton	455	olup	Cs,Fr,Fi	Fo	BO
	Chisocheton	518	pono	Fi	Fo	BO
	Dysoxylum	433	gulomik babu	Fi	Fo	PO
	Dysoxylum	503	gura			
	Dysoxylum	567	losat rimpiu	Fr,Cs,Fi,Md	Td	BO
	Dysoxylum alliaceum Bl.	716	songkat	Cs	Fo	BO
	Dysoxylum excelsum Blume	790	ungah	Fr	Fo	TO
	Lansium domesticum Correa	393	kopar	Fr,Ma,Md	PF	BO
	Lansium domesticum Correa	392	losat	Fr,Md,Fi	Pl	TO
	Lansium	0	posa	Fr	Pl	TO
	Sandoricum	401	cituar	Cs,Fr,Ut	Fo	BO
	Sandoricum	581	kulompo	Fr	Fo	TO
	?	558	palis	Md	Fo	BO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
Menispermaceae	Arcangelicia flava (L.) Merr	768	inju tono			
	Arcangelicia flava (L.) Merr.	0	inju tono	Cs,Fi	Fo	PO
	Tinospora	560	layet	Ts	Fo	TO
Moraceae	Artocarpus integer (Thunb.) Merr	383	buda	Lt,Fr,Sd,Cs	PF	TO
	Artocarpus dadah Miq	763	bulangkik	Cs,Fr,St,Hs	Fo	BO
	Artocarpus	493	bulangkik ijua	Fr,Hs,Lt,Md	Fo	PO
	Artocarpus dadah Miq.	681	bulangkik pua	Fr,Hs,Cs	Fo	
	Artocarpus	0	nangkok tuat	Fr	Fo	PO
	Artocarpus anisophyllus Miq	707	ntowo	Fr,Sd,Lt,Md,Cs	PF	BO
	Artocarpus	497	puruntat	Fr,Sd,Lt,Cs,Md	Pl	TO
	Artocarpus	384	sasap	Fr,Md	PF	BO
	Artocarpus heterophyllus	477	toyuap	Fr,Ts,Hc,Lt,Cs	Td	TO
	Ficus	360	aro	Fr,Lv,Fi	Fo	TO
	Ficus variegata Bl.	662	aro madu	Fr,Hs	Td	TO
	Ficus deltoidea	469	jukat buou	Md	Fo	BO
	Ficus fulva	349	kumpat	Fr,Ut,Fi	Fo	PO
	Ficus	573	kutokup	Fi,Fr		TO
	Ficus	452	kutumu	Fr,Fi,Cs		BO
	Ficus annulata Blume	778	kutupa	Hs,Lt	Fo	BO
	Ficus	797	mpolas	Mi	Fo	PO
	Ficus	361	ngkururua	Fr,Hs,Fi	Fo	TO
	Ficus	572	nunua	Hs,Ut	Fo	TO
	Ficus	330	nunua ciu	Hs	Fo	BO
	Prainea limpato	590	rinsuat	Fr,Cs,Fi,Sd	Td	TO
	Streblus	546	oris	Lv,Mi	Fo	BO
	Streblus ilicifolia (Vidal) Corner	794	oris	Lv,Mi	Fo	BO
	Streblus	637	uri roncis	Md	Fo	
Musaceae	Musa	0	akut	Fr,Fl	Td	
	Musa	0	goya	Fr,Th,Ut	Fo	TO
	?	529	okut	Fr,Ut	Fo	TO
Myrcenaceae	Ardisia	324	kucope	Fr,Fi	Td	BO
Myristicaceae	Knema furfuraceae (Hk.f.& Thoms) Warb	705	umpa bangko			
	Knema	652	umpa merinjok	Fi	Fo	PO
	Knema curtisii (King) Warb. var. curtisii	584	umpa mpago	Fi,Ma	Fo	PO
	Knema globularia (Lamk.) Warb	674	umpa roi	Fr,Fi	Fo	PO
	Myristica borneensiis Warb	420	umpa mpago	Fi,Ma	Fo	PO
	Myristica villosa Warb	440	umpa teribu	Fi	Fo	PO
	Tristaniopsis	586	burinas			
Myrsinaceae	Ardisia	456	kucope	Fr,Fi	Td	BO
	Ardisia	405	kucope tuat	Fr	Fo	PO
	Embelia	647	pulanua	Lv	Fo	
	Maesa	596	pumoriat	Md	Fo	
Myrtaceae	Duabanga moluccana Blume	804	binong	Cs,Fi,Sp	Td	TO
	Eugenia	482	blonsum	Md,Fi	Fo	PO
	Eugenia lineata (DC.) Duthie	748	golap	Fr,Cs	Td	PO
	Eugenia	620	mas poyu	Ut	Fo	PO
	Eugenia	571	uba bosi	Cs,Fr,Hs	Fo	PO
	Eugenia	484	uba jamo	Cs,Dy,Md	Fo	BO
	Eugenia	598	uba sama	Ho,Md,Cs,Dy	Td	
	Syzygium	417	uba poronua			
Nepenthaceae	Nepenthes sp	511	nciuat			
Nephrolepis Group	Nephrolepis exaltata	701	poku gurubua	Lv	Fo	TO
Ochnaceae	Gomphia serrata	426	pulawat	Cs	Fo	PO
	Gymnacranthera fraquhariana (Hook.f.&Th.) Warb. var. eugeniifslia	425	umpa morua	Fi	Fo	PO
Olacaceae	Ochanostachys amentacea	649	kutikar	Cs	Fo	BO
Ophioglaceae	Helminthostachys zeylanica	359	poku suar	Lv	Fo	TO
Orchidaceae	Coelogyne foerstermannii Reichb.f.	357	kutopik	Md,Fi	Fo	TO
	Niuwiedia vertrifolia Bl.	740	sabat bubuk	Md	Td	TO
	Tainia paucifolia (Breda) J.J.S.	338	ojua bankei			
	Vanilla	636	mud bongon	Md	Fo	
	?	422	sonik			
Orobaceae	Aeginetia	625	uri roncis	Md	Fo	
Oxalaceae	Averrhoa carambola L.	313	romut	Fr,Fi	Pl	TO
Oxalidaceae	Averrhoa bilimbi L.	803	burinong			
Pandanaceae	Pandanus	628	kaja ciujat	Hc	Fo	PO
	Pandanus nitidus Kurz	703	kaja ciujat	Hc	Fo	PO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
Passifloraceae	Adenia macrophylla (Bl.) Kds	653	mika akar			
Piperaceae	Piper	784	boit cumei	St	Fo	TO
	Piper	316	sakmuan	Ma	Fo	TO
Poaceae	Centotheca lappacea (L.) Desv.	689	iduh ntowo		Fo	TO
Polygalaceae	Xanthophyllum	483	boyua raua	Ut	Fo	PO
	Xanthophyllum	0	manta	Fr,Mi	Pl	BO
	Xanthophyllum	438	manta dio	Fr	Td	BO
	Xanthophyllum rufum Benn	656	ngkadit	Ut,Md	Fo	PO
	Xanthophyllum	308	uma bato	Ut	Fo	BO
Polygonaceae	Polygonum dichotomum Blume	789	uri potua			
Protaceae	Heliciopsis	454	ngkuraus		Fo	BO
	Heliciopsis	587	ridat	Cs	Fo	
Rhizomae	Anisophyllea cf grandis (Benth.) Burkill	449	ngoda	Cs,Sh	Fo	BO
	Pellacalyx axillaris Korth	578	galel	Fi	Fo	BO
Rhizophoraceae	Carallia brachiata (Lour.) Merr	704	podis	Ut,Sh	Fo	BO
Rosaceae	Prunus	633	juah balua	Cs,Fi	Td	PO
	Prunus arborea (Bl.) Kalkm	694	mamiah bangkei	Fi	Fo	
	Prunus arborea (Bl.) Kalkm	750	mamiah nangkok	Cs,Bk	Fo	PO
	Rubus moluccanus L. var. angulosus Kalkm	314	ngkorap	Fr,Md	Fo	TO
Rubiaceae	Acranthera	307	tama			
	Argostemma	346	uri popa			
	Cephaelis stipulacea Blume	782	uri timpak mud	Md	Fo	TO
	Gaertnera	534	bongkal bada	Fi	Fo	TO
	Hedyotis leucocarpa Elm	715	labdoyo		Fo	BO
	Hedyotis	459	sonia			
	Ixora	337	bunga api			
	Ixora	419	langei ngino		Fo	PO
	Ixora	409	langei ngino		Fo	PO
	Lasianthus scabridus King & G.	760	ngkudu bongko		Fo	PO
	Lecananthus	731	bora buraura		Fo	TO
	Maschalocarymbus	368	rimubu	Ho,Cs	Td	TO
	Maschalocorymbus	570	bongkal	Fi	Fo	BO
	Morinda	553	ngkadu			
	Musaenda	387	tiua munsa	Fi,Tr	Fo	BO
	Nauclea subdita (korth.) Steud	672	bongkal ciu	Fi,Mi	Fo	TO
	Oldenlandia capitellata (Wall.) O.K.	755	ngkuduap	Md	Fo	TO
	Paederia verticillata	517	radis	Ts	Fo	PO
	Pavetta	602	bangar		Fo	BO
	Pavetta axillaris Brem	732	cobur		Fo	TO
	Pavetta axillaris Brem	685	moda babu	Fi	Fo	BO
	Porterandia	470	tiua munsa	Fi,Tr	Fo	BO
	Psychotria	556	kucope tono	Fr	Fo	PO
	Psychotria	566	riba	Md,Ut	Fo	BO
	Randia corymbosa Boerl	739	pulangeia ngino	Fi	Fo	PO
	Randia densiflora (Wall.) Benth.	793	rinjuh	Fi	Fo	BO
	Saprosma	551	kantuat	Lv	Fo	TO
	Streblosa	301	nusap muan	Md	Fo	TO
	Timonius compressicaulis Boerl.	0	onuam		Fo	TO
	Timonius compressicaulis Boerl	720	onuap			
	Uncaria	312	luyak	Mi,Fi	Fo	BO
	Urophyllum hirsutum (Wight.) Hk.f.	726	bongkal ciu	Fi,Mi	Fo	TO
	Urophyllum	322	bongkal raua	Fi	Fo	BO
	Urophyllum	442	oniah			–
	Urophyllum	495	oniah			
	Urophyllum	404	riminso	Fi	Fo	PO
	Urophyllum	414	tingko	Ut,Fi	Fo	BO
	Xanthophytum	579	ribomo	Mi	Fo	BO
Rutaceae	Euodia	501	simula			
	Pleiospermium	807	rumutuat			
Sapindaceae	Lepisanthes	386	ngungu	Md,Lv	Td	BO
	Lepisanthes	565	nturei jora	Fr	Fo	BO
	Nephelium	0	ciubo	Fr,Fi	Fo	
	Nephelium	0	galok	Fr,Fi	Td	TO
	Nephelium	0	halup	Cs,Fr	Fo	PO
	Nephelium	0	kosua taba	Fr,Fi	Td	
	Nephelium	0	kucubo	Fr,Fi	Fo	
	Nephelium	474	pongo bioa	Cs,Dy,Fr	Td	TO

APPENDIX 4.4 (cont'd)

Botanical family	Binominal	Collection number	Local name	Use	Cultivation status	Habitat
	Nephelium	0	puduh bongko	Fr,Fi	PF	TO
	Nephelium	0	ramuat bona	Fr,Fi	Td	PO
	Nephelium	0	rimonyo	Fr,Fi	Td	BO
	Nephelium	506	romuan	Fr,Sd,Fi	PF	BO
	Nephelium	0	ronyap	Fr,Fi	Td	TO
	Nephelium	0	sangou	Fr,Fi	Td	TO
	Nephelium	574	subu	Fr,Sd,Cs,Fi,Dy,Md	PF	TO
	Nephelium	0	tociubo	Fr,Fi	Td	TO
	Nephellium	473	poriat	Cs,Fr,Dy,Fi	PF	TO
	?	616	buliti	Fr,Sd,Fi,Cs,Mi	Pl	TO
	?	605	dumpei	Fr,Fi,Cs,Dy,Mi	PF	TO
Sapotaceae	Palaquium	0	njotu jangkar	Fr,Cs,Fi	Td	BO
	Palaquium	0	njotu mangka	Fr,Hs,Cs	Fo	
	Palaquium	0	njotu rajo	Cs,Fr,Md,Fi,Mk	PF	BO
	Palaquium calophyllum (T.&B.) Pierre	533	sabak muan	Cs,Fr,Hs	Td	BO
	Payena acuminata (Bl.) Pierre	788	njotu bulajat	Cs,Hs	Td	TO
	Payena acuminata (Bl.) Pierre	0	njotu entumum	Cs,Hs	Td	TO
	Payena acuminata (Bl.) Pierre	742	njotu entumun			
Schisaceae	Kadsura	550	ringin	Cs,Fi	Fo	TO
Selaginellaceae	Selaginella	609	mogat		Fo	TO
Sibiaceae	Meliosma sumtrana (no liana/noexudate)	626	pese	Ts	Td	
Sterculiaceae	Commersonia bartramia	639	rubuh	Bk,Ut	Fo	
	Leptonychia caudata	613	ntowo apuat	Fr	Fo	
	Leptonychia heteroclita	654	ntowo muan	Fr,Bk	Fo	
	Pterospermum	0	bayuar	Bk,Cs,Ut	Td	TO
	Sterculia	555	sumpa mporua	Sp	Td	BO
Symplocaceae	Symplocos	407	ribubontua tuat			
	Symplocos cf fasciculata	542	ribubontua	Md,Fi	Td	BO
Theaceae	Adinandra	502	babua	Cs,Lv,Fi	Fo	TO
	Ploiarium alternifolium (Vahl.) Mel	679	jongir			
Thelypteridaceae	Sphaerostephanos heterocarpus (Bl.) Holtt	699	poku ntowo	Lv	Fo	TO
Thymelaceae	Aquilaria Beccariana Tiegh	583	taba nunua	Mi	Fo	PO
	Gonystylus bancanus (Miq.) Kurz	663	putat	Fp	Fo	BO
Tiliaceae	Brownlowia	310	panoalat	Cs,Sd,Ut	Td	TO
	Brownlowia	379	panoalat	Cs,Sd,Ut	Td	TO_
	Diplodiscus	618	kugarap	Dy	Fo	BO
	Grewia	619	koyas	Cs,Hs,Md	Fo	TO
	Microcos	369	bunga domua	Fr,Fi	Fo	BO
	Microcos	411	bunga domua tuat	Fr,Fi	Fo	
	Microcos	465	juah sonya			
	Schoutenia glomerata King	802	gaug	Ut	Td	TO
	Trichospermum	611	gomo	Ts,Ut	Fo	TO
Ulmaceae	Gironniera	388	gumuruah	Cs,Fi,Hs	Td	BO
	Trema	437	buruh	Ut,Fi	Fo	TO
Urtaceae	Dendrocnide	355	api		Fo	TO
	Dendrocnide	380	api		Fo	TO
	Elatostema	610	kuru tuat	Lv	Fo	TO
	Leucosyke capitellata	638	sidu kurosiet	St	Fo	
	Poikilospermum	325	murap		Fo	TO
Verbenaceae	Callicarpa	315	tubibongis	Fr	Fo	TO
	Clerodendrum	464	koyuh kopi			
	Clerodendrum laevifolium Blume	785	kukapar		Fo	TO
	Clerodendrum	342	kura pojet	Md	Fo	TO
	Clerodendrum	309	pangel			
	Geunsia	373	bilou	Fi	Fo	TO
	Petrea	746	bumu boras	Lv	Fo	PO
	Premna	488	banua	Cs,Ut,Hs	Fo	TO
	Sphenodesme	513	se	Ts	Fo	BO
	Stachytarpheta jamaicensis	366	ngkuraus herb	Md	Fo	
	Vitex	385	ngaruat	Lv,Fi	Fo	TO
Vervenaceae	Petraeovitex tripoliata Merrill	650	mikau akar			
Violaceae	Rinorea angnifera (Lour.) O.K.	687	ngkadit	Ut,Md	Fo	PO
	Rinorea macrophylla (Miq.) M.A.	350	ntowo muan	Fr,Bk	Fo	
	Rinorea	606	tabiet kurocap	Lv,Fr	Fo	
Vitaceae	Cissus	595	daut kopik bubut	Mi	Fo	PO
	Cissus	559	mika			
	Pterisanthes	428	uri barit	Md	Fo	PO

APPENDIX 4.4 (cont'd)

Botanical family	**Binominal**	**Collection number**	**Local name**	**Use**	**Cultivation status**	**Habitat**
Zingiberaceae	Alpinia	608	daut popardoyo	Md	Fo	TO
	Alpinia	378	ngkalo	Fl,Sd	Fo	TO
	Alpinia	582	songa turei			
	Amomum	328	cupak ankua	Md	Fo	BO
	Amomum	331	songa rapat	Fr,Sd,Lt	Fo	BO
	Amomum	491	songa ronka			
	Costus speciosus	569	obul obul	Lv,Ma	Fo	TO
	Globba panicoides Miq.	696	patok malap	Md	Fo	
	Globba	303	patok malap	Md	Fo	
	Globba atrosanguinea	336	sidutriu			
	Plagiostachys	580	kusorei	Fr	Fo	BO

No. identification						
		593	ngkoruh			
		589	songa tono	Fr,Cs	Fo	BO
			abang poriat	Cs,Ho	Td	PO
			adit	Mi	Fo	PO
		6	akar burowat			
		72	akar garap			
			anuap	Cs	Fo	TO
			baca		Fo	
		928	balang burut			
			balou		Fo	TO
			banan	Cs	Fo	TO
			berintirok		Fo	BO
			bia			TO
		963	boit odut	St	Fo	TO
		962	boit rimoua	Md	Fo	TO
		721	bojuh bida	Cs	Fo	BO
			bongkua tobu	Sd,Fi	Fo	PO
			bora nun	Lt	Fo	
			boyua	Fp,Cs	Fo	PO
			boyua rabei	Fp,Cs	Fo	PO
		957	buat nunua			
		692	buat raua	Ts	Fo	BO
		976	bubut			
			bugek	Fi	Fo	
			bungka	Lv,Fr,Fi,Md	Fo	TO
			burinang	Fr,Lv	Pl	TO
		615	burowat	Md	Fo	BO
		797	cokas	Hs,Cs	Fo	BO
		992	danan	Ts,Hc,Mi	Fo	TO
			daut kurinso	Md	Fo	
			daut pala	Mi	Fo	TO
			daut pumoriat	Md	Fo	TO
			daut rabu	Mi	Fo	PO
			sompua			
			daut rayo	Mi	Pl	TO
		950	gala			
			gang	Ts	Fo	
			gatu	Fr,Fi	Td	PO
			gilapa	Hc,Ts	Td	PO
			gogap	Ts	Fo	PO
			gomi	St,Fi,Md,Cs	PF	BO
		680	gurama	Cs,Hs	Td	BO
			guranja akar	Fr	Fo	
			ikat kancik		Fo	
			inju tono akar		Fo	
			ira	Cs	Fo	
			jebulu	Fi	Fo	
			jeronaka	Fr	Fo	TO
			jiruntua	Cs,Lt	Fo	
			jito	Cs,Lt	Fo	TO
		719	juah mpilok	Cs,Fi	Td	PO
		44	jukat coku	Md	Fo	PO
			kaja	Hc	Fo	TO
			kaja kajo	Hc	Fo	PO
			kaja sinsik	Hc	Fo	TO
			karet	Lt,Lv,Sd,Fi	Pl	TO

APPENDIX 4.4 (cont'd)

No. identification	Collection number	Local name	Use	Cultivation status	Habitat
		kobal babi	Md	Fo	PO
		kocup	Fr,Hs	Fo	PO
		kopi	St,Lv,Fi	Pl	TO
		korua	Cs,Lt	Fo	TO
	644	kosaumpo	Fi	Fo	BO
		koyuh garu	Cs,Mi	Fo	PO
		koyuh inju	Cs	Fo	PO
		koyuh kopi	Ut,Fi	Fo	PO
		kubatu	Cs	Fo	
		kubulo	Fr	Fo	
		kuciro rue	Tr	Fo	PO
		kucope dorit	Fr,Fi	Fo	
	345	kucubat dio	Fr	Td	PO
		kudiat	Hs,Cs	Td	
		kudojuat	Cs,Fr,Hs	Fo	PO
		kudu bongko	Fr,Fi	Fo	
		kudu nua	Fr,Cs,Hs	Fo	PO
		kuduar	Cs,Fr,Lv	Fo	PO
		kugarap akar	Md,Dy	Fo	BO
		kugaru	Cs,Mi	Fo	PO
	781	kuinju	Fi	Fo	BO
	980	kuladat	Cs,Bk,Da,Md	Fo	BO
		kuladat akar	Hc	Td	PO
		kupantial	Cs	Fo	TO
		kura bankei	Md,Mi,Fi	Fo	PO
	761	kuronga	Cs	Fo	BO
		kuronje	Fr,Fi	Td	BO
		kuronje bua	Cs,Fr	Td	PO
		kuruat mia	Cs,Sd	PF	BO
		kurumpik ciou	Cs	Fo	PO
		kuruna	Md	Fo	
		kusongkok	Fr	Td	BO
		kutangkol	Ho	Td	PO
	20	kutopik	Md,Fi	Fo	TO
		laboka	Fi	Fo	
	9	lale	Fi,Ut	Fo	BO
		lale tuat	Fi	Fo	PO
		lamei awi		Fo	
		langkat jagok	Cs	Fo	PO
		lato	Cs	Fo	TO
	60	libama		Fo	BO
	918	limpayak	Cs	Fo	PO
		liposo	Fr		
		lobat		Fo	
		lowo rajo	Hc	Td	PO
		lukei	Bk		
		majou botu	Cs	Fo	
	733	mamiah rimabi	Cs,Bk	Fo	PO
	381	mania	Su,Hc,Fr,Cs,Sa, Lv,Mk	Pl	TO
		manta boyua	Fr,Cs,Fp	Td	PO
		manta ratei	Fr,Cs	Td	PO
		manur	Fr,Cs	Td	BO
		maya	Fr,Ma	Pl	TO
		mikau	Lv,Ts	Fo	_
	600	moda	Cs	Td	BO
	675	moda coman	Cs,Fr,Hs	Td	PO
		molik	Cs	Fo	PO
		moris	Cs	Fo	PO
		mowa	Fr,Lv	PF	TO
		moyu bora nun	Fr	Td	PO
		moyu damar	Fr	Fo	
	959	mpele	Fr,Hs,Fi	Fo	BO
	669	mpilis	Cs	Fo	BO
		mpoya bai		Fo	BO
		mpoya raua	Cs,Fi	Fo	PO
		mubei nontat	Cs	Fo	PO
		nayu	Fr,Ut	PF	
		ngansei	Cs	Fo	
		ngirat teribu	Cs,Fi	Fo	PO
	657	ngkadit	Ut,Md	Fo	PO

APPENDIX 4.4 (cont'd)

No. identification	Collection Number	Local name	Use	Cultivation status	Habitat
	734	ngkala dioa	Md	Fo	BO
		ngkokar	Cs,Fp	Fo	PO
		ngkua	Fr,Cs,Ho	Td	BO
		ngkubak dorit	Fi	Fo	
		ngkudu	Lv,Md,Dy	Pl	TO
		ngkurari tapa	Cs,Fi	Fo	PO
	691	ngonap	Hs	Fo	
		njoman rajo	Md	Fo	
		njoman ukut	Md	Fo	
	630	njotu bisi	Fr,Cs,Lt	Td	PO
		ntauh	Cs,Hs	Fo	PO
		ntawuar	Cs	Fo	PO
		nunua boras	Hs	Fo	PO
	658	nunua boras	Hs	Fo	
	710	nunua mika	Hs	Fo	PO
	722	ojua teribu	Md	Fo	TO
		osue pido	Fr	Fo	
		pancit bua	Fr	Td	PO
	999	panok	Mi	Fo	BO
	993	pantar	Hc	Td	PO
		para	Cs	Td	PO
		paro ponou	Cs	Fo	PO
	69	patok malap	Md	Fo	
	562	perijis	Hc,Ts	Fo	TO
		pese ramuan bona	Ts	Td	BO
		podi	Fr,Hc	Td	
	917	pontou	Cs,Lt	Fo	PO
		poruat		Fo	PO
		posit poyu	Cs,Lv	Fo	TO
		puduh	Bk	Td	BO
	530	pulangeia	Lv,Ma	Fo	BO
		punjau	Ho,Cs	Td	TO
		puroguk	Cs,Fi	Td	BO
		puruat	Hc	Td	
	735	putas		Fo	PO_
	921	putei	Fr,Lv,Fi	Td	BO
		rabu sampua		Fo	PO
		radah kupose	Md	Fo	TO
		radei samun	Md	Fo	
	989	radis	Ts	Fo	PO
		rajo	Ma	Fo	PO
		rakak	Lv	Fo	TO
		raso		Fo	PO
		riap	Hc	Td	PO
		riat bauh	Fr	Td	BO
	54	riba	Md,Ut	Fo	BO
		ribokat	Cs,Bk	Td	TO
		rimingkei	Ho,Cs,Fr,Hs	Td	PO
	786	rimongan	Fi	Fo	BO
		ringango	Ut	Fo	
		ringkajak	Cs	Td	PO
		ringkunyian	Bk	Td	TO
		rinsi	Cs	Td	PO
	374	rokow	Cs	Fo	TO
		rongo	Fr,Mi	Fo	TO
		rubu boncik	Md	Fo	
	973	rubuat	Cs,Lt,Ut,Ho	Td	TO
		rudut		Fo	PO
		rudut babu		Fo	PO
		rute	Fi	Fo	
		ruwei boncik	Fr	PF	PO
	974	sabak bunjawei	Mi	Pl	TO
		sampa	Fr,Fi,Ma	Td	TO
	964	santua	Fr,Lv	Pl	TO
		siburu	Lv	Fo	BO
		simubua	Fr	PF	BO
		songa	Th,Fr	Fo	BO
		soran tua	Md	Fo	
		sukuap	Fr,Lt	Fo	PO
		sumei muan		Fo	TO

APPENDIX 4.4 (cont'd)

No. identification	Collection Number	Local name	Use	Cultivation status	Habitat
		sumpa buliua		Fo	PO
		suwet	Fr	Fo	TO
		taba podi	Mi	Fo	PO
		tabiat	Lv	Td	PO
	84	tajuar	Ma	Fo	BO
		tangan	Fr	PF	BO
		tangan buo	Fr	PF	PO
		tangan koro		Fo	
		tangan osup	Fr	PF	BO
		tangan rei	Fr	PF	PO
		tanta	Cs,Hs	Fo	TO
	629	tanua nun	Cs,Lt	Fo	
		tapa lobo	Fr	Td	BO
	998	tapah	Hc	Fo	
	723	terintik kosuh	Hc	Fo	PO
		tete	Fr,Lv	PF	TO
		timong	Cs,Bk	Fo	PO
	332	timpak mud	Md	Fo	TO
		toli	Fi	Fo	TO
		topo		Fo	TO
		topo oso	Ma	Fo	BO
	4	tugek	Fr,Fi	Td	TO
		turuh	Cs,Mi,Ut	Fo	TO
		uba pingat	Fr,Cs,Hs	Fo	PO
		uba puronua	Fr,Cs,Hs	Fo	BO
		uma payo	Fi	Fo	TO
		umki manis	Hc,Ts	Fo	PO
		umpa	Fr,Lv,Fi,Cs	Td	BO
		umpa mpomon	Fr,Fi	Fo	PO
		uri bongka	Md	Fo	
		uri icok	Md	Fo	
		uri ntoci doyo	Md	Fo	
	693	uri poto	Md	Fo	
		uri sonia	Md	Fo	TO
		uri toni	Md	Fo	

Uses of plant species in Ngira, and the codes for these uses

Bk	Bark used as strips	Ho	Trees visited by bees that yield honey	Sa	Stem yields edible starch
Cs	Construction	Hs	Hunting site	Sd	Edible seed
Da	Yields damar	Lt	Sticky latex used to catch birds	Sh	Used to make shingles (roofing)
Dy	Dye	Lv	Edible leaves	Sp	Support tree
Fi	Firewood	Md	Medicinal	St	Stimulant
Fl	Edible flower	Ma	Magic	Su	Sugar producer
Fp	Fish poison	Mi	Miscellaneous	Th	Thatch
Fr	Edible fruit	Mk	Marketable product	Tr	Used to make traps
Fv	Fruits eaten as vegetable	Pc	Pesticide	Ts	Tie stuff
Hc	Handicraft	Ph	Edible palm heart	Ut	Utensils

Cultivation status of plant species in Ngira, Koli, Teriang:
Pl = domesticated species
PF = planted in forests or in gull grown forest garden (tembawan)
Td = tended when spontaneously occurring in forest gardens or forests
Fo = not planted, nor tended

Habitat of plant species in Ngira, Koli, Teriang
PO = species only found in pulau rimba (high forest remnant)
TO = species only found in tembawang (forest garden)
BO = species found in both pulau rimbab and tembawang

CHAPTER 5
MANAGEMENT OF SWIDDEN FALLOW SECONDARY FORESTS[1]

1. INTRODUCTION

Swidden fallow secondary forests (SFSF), defined here as regenerating woody fallows of swidden agriculture for the purpose of regenerating the land and providing products and services for farmers (Chokkalingam and de Jong 2001) are an important component in the forest landscape among swidden agriculturists in Kalimantan and in other parts of Indonesia. SFSF is a dynamic forest type, as it is part of swidden agriculture that is based on processes of slashing vegetation and leaving fields fallow to restore nutrients. Until recently, official government sources attributed at least half of the approximately 1 M ha of annual forest conversion in Indonesia to swidden agriculturists (e.g. Kartasubrata 1993). Other sources have blamed the logging industry as a major factor (Sunderlin and Resusodarno 1996; Repetto and Gilles 1988). In recent years logging and large scale estate crop development, especially oil palm, and industrial timber plantations, contribute the largest part to forest conversion in Indonesia (Potter and Lee 1998). However, there is no doubt that large areas of Indonesia have experienced swidden agriculture, and large areas are under SFSF.

Based on interpretation of satellite imagery in 1980, the area of forest fallow derived from swidden agriculture in closed broadleaf forests was estimated to be 13.5 M ha (Weinstock & Sunito 1989 cited from FAO 1981: 218). On the other hand, in the RePPProt (1990) the area provided was 11.4 M ha, which included both swiddens and fallow land. Sunderlin and Resosudarmo (1996), using a World Bank study from 1990 that was based on the same RePPProt reports, estimate that swidden agriculture covered an area of 14 M ha in Sumatra, 11 M in Kalimantan, and 2 M ha in Irian Jaya. These totals, however, group together everything from swidden fields, fallows, shrub lands and grasslands. The existing data do not provide a clear picture of the area of secondary forest generated by swidden agriculture and how this is changing.

In Indonesia's secondary forests associated with swidden agriculture much of the natural regeneration is blended in with a planted or tended component. The planting of trees on swiddens, a common practice in Indonesia, results in vegetation that can be classified as secondary forest gardens (Chokkalingam and de Jong 2001).

[1] This chapter is based on two papers: W.de Jong, M. van Noordwijk, M. Sirait, N. Liswanti, Suyanto. Farming secondary forests in Indonesia. Journal of Tropical Forest Science 14 (3) 2001. W. de Jong. Forest management and ethno-classification of fallows: The case of *Bidayuh* farmers in West Kalimantan. In Press, ICRAF Southeast Asia office, Bogor.

Secondary forest gardens are considerably enriched swidden fallows, or less-intensively managed smallholder plantations where considerable spontaneous regeneration is tolerated, maintained, or even encouraged. Secondary forest gardens maintain an important component of spontaneous vegetation that is similar to the vegetation on SFSF. The proportion of this spontaneous vegetation is inverse to the presence of the planted component and the amount of weeding conducted.

This chapter brings together information on the status and the dynamics of secondary forest as part of swidden agriculture in Kalimantan, while putting it in a broader perspective, using information on general trends in Indonesia. Section two provides an overview of the diversity of the different types of swidden agriculture in Indonesia and the related role of secondary forests. Section three discusses one example of knowledge on the ecology of several swidden fallow secondary forest types, and how this is translated in related tree planting activities. Section four will provide some evidence of the transition from SFSF to secondary forest gardens or smallholder tree crop production systems, although this topic is discussed in more detail in Chapter Six of this volume. Section five discusses national policy that affects swidden agriculture and secondary forest management, while section six draws some general conclusions from these discussions.

2. DIVERSITY IN SWIDDEN AGRICULTURE IN INDONESIA

The lack of clarity in data regarding swidden and SFSF, as explained in the introduction, is in part a result of the confusion regarding the agricultural practices being referred to. Swidden agriculture refers to ‘swiddening’, or temporary removal of the woody vegetation on a plot for agricultural production, and is part of a long-term rotational land use practice that allows for the development of SFSF. It is more commonly referred to as shifting cultivation, but we suggest to identify it as “typical” swidden agriculture systems, still present in Kalimantan and West Papua. This practice is not properly distinguished from the opportunistic opening of forest lands for agriculture by recent migrants who arrive from densely populated islands. These farmers slash and burn small patches of forest, plant a staple crop and then a cash crop. The cash crop may be pepper, as was the case for migrants from Sulawesi to East Kalimantan. Many of these farmers continued to grow pepper for 10 to 20 years on the same plot and then moved on to other areas after the soils were totally exhausted. Other examples are migrants from Java who opened new lands in Sumatra where they planted rubber. The migrants involved in these types of forest conversion may have come to the more forested parts of Indonesia via the government-sponsored transmigration programme, have moved on their own accord to start a farm in areas where land is easier to obtain, or have moved initially to work in logging concessions or the plantation industry.

Factors that contribute to the varying prominence of secondary forest among "typical" swidden agriculturists are biophysical conditions of the locations (mainly soil and climate), and several economic and socio-cultural traits. Among the latter, population density is of major importance, influencing to a large extent the duration of fallow, and subsequently the kind of vegetation that develops on the fields. Additional factors include the main crop being produced and the number of cultivation cycles before the field is fallowed, also to a large extent a function of biophysical conditions. Table 5.1 lists shifting cultivator groups in Kalimantan, Sumatra, Sulawesi, and Irian Jaya, indicating differences in several attributes related to the land use practice.

Table 5.1 Features of swidden agriculture of various groups in Indonesia (Adapted from Waridinata, Sunito and Ngo 1990)

Location	Group	Main crop	Tenure	Cropping period	Fallow period in years	Emerging tree crop
Sumatra	Sakai	Rice	Kinship/ clan	1 year	3-7 years (previous15-20)	Rubber
	Akit		Patrilineal			
	Melayu		Clan	2-3 years	7-10 (15-20)	Rubber
Central Kalimantan	Ngaju	Rice	Kinship/ villages	1 year	3-7 to 15-20 years	Rubber and rattan
	M'ayanan	Rice	Eldest son/ village	1 year	3-7 to 15-20 years	Rubber and rattan
Sulawesi	Muna		Private/ kinship	1-2 years	3-4 years	Cashew
	Noronene		Tribal/ some private rights	2 years	2-4 years	Cacao
	Tolaki			1-2 years	3-4 years	Cashew
Irian Jaya	Dani	Sweet potato, taro	Clan/ tree crops private. Inherited to eldest son	2-5 years	3-7 years (5-10 years)	
	Butonese	Vegetables for markets	Share cropping. Land owed by clan	1-3	3-5 years	

2.1 Diversity in swidden agriculture and related variation in the presence of secondary forests

Using examples from Kalimantan, this section suggests how this diversity in agricultural practices results in different presence and role of secondary forests in the landscape. Farmers of one of the swidden agricultural groups of Borneo, the *Iban* farmers, mostly from Sarawak, historically preferred to make fields in mature natural forests rather than secondary forests (Freeman 1955). This type of swidden agriculture leads to large areas of secondary forests on land that had experienced only one cropping cycle. Groups like the *Kenyah* and *Kayan* from the eastern parts of Kalimantan cultivated the area around a new settlement for several decades, and then moved the whole village to a new site, leaving the land to recover over a long time. Jessup (1981) claims that *Kenyah* farmers purposely maintain a sufficient large area of swidden fallow secondary forest to assure the supply of useful species that can only be found in this vegetation.

Bidayuh farmers from West Kalimantan and Sarawak (King 1993), practiced a more sedentary swidden agriculture compared to other groups. When *Bidayuh* villages became too large, they split up and only portions moved to a new area of forests to start a new settlement. Long residence in a single region implies that a *Bidayuh* farmer must have a sufficiently large holding under various stages of fallow. This holding is to be built up gradually from when a newly wedded couple becomes an independent farming household, until the area is large enough such that fields can be used and fallowed at sufficiently large intervals. However, a *Bidayuh* holding would on average still have less secondary forests than for instance the ever-moving *Iban* farmers (Winzeler 1993). In a typical *Bidayuh* landscape there is little old growth secondary forest, as may be common in old *Kenyah* and *Kayan* settlements, unless it had been converted to secondary forest garden. Among *Bidayuh* farmers land tenure claims are strong, and are held by descendants for many generations, even after a settlement splits and one part of the community moves elsewhere. *Bidayuh* farmers also placed more emphasis on tree planting and conservation of primary forest reserves. Table 5.2 provides some data on the areas under swidden and the areas under fallow in four villages in West Kalimantan.

Table 5.2 Areas under swidden and under fallow in four Bidayuh villages in West Kalimantan

Village	Year	Swidden	Fallow
Sanjan [1]	1991	0.89 ha/family	9.7 ha/family
Tunguh [1]	1990	1.19 ha/family	5.6 ha/family
Ngira[2]	1994	3.2 ha/family	14.3 ha/family
Koli[2]	1994	4.2 ha/family	18.9 ha/family

(1) Momberg, 1993. (2) de Jong, field notes.

3. MANAGEMENT OF SWIDDEN FALLOW SECONDARY FORESTS

SFSF have a multiple set of functions in swidden agriculturist's resource management. Their principal function often remains restoration of the nutrient stock for a subsequent cropping of the field. In addition, SFSF provide a considerable number of useful species, that may be consumed when appropriate. As mentioned above, and argued in more detail in Chapter Six, often some degree of tree planting may go on in SFSF, which may, or may not result in the conversion of the vegetation into a secondary forest garden (e.g. de Jong 1995b). This section highlights a particular aspect of SFSF management among swidden agriculturist in West Kalimantan, that relates to its conversion to alternative land-use, and that takes it out of the strict swidden fallow cycle.

Among *Bidayuh* farmers upland swidden agriculture fields are used for one year to grow rice and then are fallowed. Farmers recognise that the length of time a field has to be fallowed before it can be used again, varies according to the land-use history, the topography, and the soil quality of the field. Farmers also understand that the type of vegetation that develops differs according to the same characteristics, and that the vegetation indicates the land-use potential of a site.

In Ngira, one of the villages where the research on local forest management in Kalimantan took place, (see Chapter Two), farmers distinguish three main types of fallow vegetation, in relation to the number of times that a field has been used as a swidden (Table 5.3). *Jamie rintu* is the fallow vegetation in a field which was made in mature natural forest, and possibly can be used within one or two years, if needed. *Boruat* is the fallow vegetation which usually develops in a field that already has been used two or three times for rice growing. As a rule, such a field can be used again after 3-5 years, but if a farmer has enough land, then it is preferred to leave the field under fallow until older forest develops. *Doda* is a fallow vegetation from a field which has been used to make a swidden four times or more. Dominant species in such a field are low shrubs, ferns, and *Imperata cylindrica*. On land of lower agricultural quality like mountainous land, *doda* vegetation already may develop after three or even two use cycles. Ideally, a field with *doda* vegetation has to be left fallow long enough until it develops vegetation similar to *boruat* vegetation (which may last about 10 years or more). Once a new swidden is made, again *doda* vegetation will develop. Such a field has to be left fallow for a very long time before it can be used again to make a swidden.

Table 5.3 Classification of swidden fallow secondary forests among various groups in Kalimantan

Sanjan (Bidayuh, West Kalimantan)[1]	Domun mudah = low young secondary forest
	Domun tua = old secondary forest
	Jamih = secondary forest with shrubs
	Kukot = extremely degraded secondary vegetation
Long Ampung (Kenyah, East Kalimantan)[2]	Bekan = new fallow
	Jekau Bu'et = young secondary forest
	Jekau Dadu' = old secondary forest.
Ngira (Bidayuh, West Kalimantan)[3]	Jamie rintu = cleared once
	Boruat = cleared twice
	Doda = cleared at least three times
Sanggau (Bidayuh, West Kalimantan)[1]	Jami tuh = once cleared
	Jamie ongun = twice cleared
	Jamih risaa = 3-4 times cleared
	Damuh = old secondary forest.

(1) Momberg, 1993. (2) Colfer *et al.* 1997. (3) de Jong, field notes.

Similar classifications can be found among other groups in Kalimantan. Table 5.3. reports classifications found among the villagers in Sanjan, West Kalimantan (Momberg 1993) and among *Kenyah* farmers in Long Ampung, East Kalimantan (Colfer and Dudley 1997). The latter classifications are principally based on physiognomy of the secondary forest. On the other hand, the classifications among the two *Bidayuh* groups in Sanngau (Momberg 1993) are mainly based on land use history of the site, just like the case described by de Jong (2001a).

Some changes that may occur in a fallow vegetation cover in relation to the number of times a field has been used for agriculture is indicated in Table 5.4. This table shows that more frequent use shifts the composition of species typical for more disturbed vegetation, like *Vitex pubescens* which is a common invader of *Imperata cylindrica* grasslands (e.g. Utama *et al.* 1999).

Table 5.4 Importance value* of the most common species in fallows in relation to the number of times the vegetation on fields has been slashed (adapted from Sahid, 1995)

Field slashed	1 time	2 times	3 times	4 times
Macaranga gigantea	100	26		
Macaranga sp.	53	70	65	
Coelgyne sp.	53	13	42	
Macaranga beccariana	23	56	27	16
Lygodium sp.	19			
Ilex sp.		46	67	96
Vernonia arbore				31
Vitex pubescens				61
Psychotria sp.				16

* Importance value is the sum of relative density, relative frequency and relative dominance.

It is common knowledge among *Bidayuh* farmers that once a field has reached a stage where *doda* vegetation develops, the danger of the field developing an *Imperata cylindrica* dominated grass vegetation becomes imminent. Such grass vegetation may become almost permanent when it burns every one or a few years. Rather than continuing to reserve such land for future rice production, farmers reportedly consider it a better option to plant such fields with trees. The data collected among *Bidayuh* farmers suggest that this is indeed happening. In Ngira, during the period between 1984 and 1993, a total of 510 agricultural fields were made in secondary forest: 130 in *jamie rintu*, 247 in *boruat*, and 133 in *doda* vegetation. During that same period 71% of the fields made in *doda* were planted with trees, while this happened in only 13% of the fields made in *jamie rintu*, and in 45% of the fields made in *boruat* forest (Table 5.5).

Table 5.5 Preference of fields designated to tree planting according to previous fallow vegetation between 1984 and 1993

Fallow type	No. of swiddens	% planted to trees
Jamie rintu	130	13%
Boruat	247	45%
Doda	133	71%

Most of the *doda* fields, in danger of turning into *I. cylindrica* grassland, were effectively taken out of the rice cultivation cycle by planting them with trees. This included *doda* fields that were located at large distances from villages, where rubber planting would not immediately be expected as it increases travel time for future daily rubber tapping expeditions. These data imply that the land use choices, including choices for crop production and choices for tree planting are local methods to save land which has been used repeatedly for rice production from turning into *I. cylindrica* grasslands which have little economic value for *Bidayuh* farmers.

4. TRANSFORMATION OF SWIDDEN AGRICULTURE AND RELATED SECONDARY FORESTS

The previous examples suggest the kind of endogenous forces that shape SFSF management. Changes in SFSF management can also be observed when looking at the evolution of swidden agriculture and related SFSF management in general. Richards and Flint (1994) summarised land use change data for South and Southeast Asia from 1880 to 1980, and showed a decreasing level of dependence on shifting cultivation in the region. Though swidden agriculture is still an important subsistence strategy for many rural farmers in Indonesia, its overall importance is decreasing and there are large regional differences. Van Noordwijk *et al.* (1996) distinguished four groups of provinces (Table 5.6) on the basis of the timing of the transition.

Table 5.6 Provinces in Indonesia and transformation of swidden agriculture into permanent agriculture

Provinces	**Status swidden agriculture transformation**
Java + Bali	Transformation to permanent agriculture was virtually completed by the end of the 19th century
N. and W. Sumatra and S. Kalimantan	Land use intensification had progressed by the end of the 19'th Century, but the process appeared to stall in the first half of the 20th Century
Most of Sumatra and Sulawesi	Transformation essentially took place between 1880 and 1960, with remnants of swidden agriculture persisting until the end of the 20th Century
Rest of Kalimantan and Irian Jaya	Transformation started during the 20th Century, earliest in W. Kalimantan and last in West Papua.

There is also ample evidence of processes of transformation from swidden agriculture to a mixed rice – tree crop based production systems. Some of the tree plant practices described in section 3 are part of this transformation. The factors that trigger this transformation are population density and related land use pressures, engagement with the cash economy, and to some extent state agency's policing. The precise direction of this transformation is primarily influenced by two factors: existing tree planting and forest management practices, and the opportunities to obtain cash from rubber production. Chapter Six, this volume analyses the transformation of swidden agriculture and related forest management, and suggests some impact on the forest landscape.

In most of Sumatra the dependence on swidden agriculture decreased rapidly in the period 1900 – 1930, also largely caused by the introduction of rubber. Production of upland rice combined with gathering from SFSF shifted to a main focus on rubber production. In the latter system, upland rice is planted partly paying for the cost of establishing and protecting the rubber plot. Elsewhere in Sumatra other types of secondary forest gardens emerged, such as the *Shorea javanica* agroforests (Torquebiau, 1984), and the durian secondary forest gardens, similar to the *tembawang* of Kalimantan.

The countrywide implications of these trends are reflected in the statistics on smallholder tree production. Indonesia had in 1994 some 9 M ha under rubber, coconut and oil palm, over half of which was located in Sumatra. Smallholders grow most of the rubber and coconut in Indonesia (Sunderlin & Resosudarmo 1996). As indicated above, much of the smallholder rubber is still produced in stands that may be considered as secondary forest gardens.

5. POLICIES AFFECTING SWIDDEN FALLOW SECONDARY FORESTS

Arguably, one of the most important instruments to influence evolution of swidden agriculture, and related secondary forest and other kinds of forest management, is through policy actions. Indonesia, like so many other countries in the region had, and still has a policy of condemnation of swidden agriculture. The country has implemented several smallholder tree-planting programmes to address "the problem" of swidden agriculture. A few older programmes are the Rehabilitation and Expansion of Export Crops Programme, the Tree Crop Support Project and the Smallholder Rubber Development Project. These schemes attempted agricultural intensification by means of tree crop production. For instance, the Rehabilitation and Expansion of Export Crops Programme offers credit to smallholders to incorporate high yielding rubber varieties in their holdings. Farmers have to be willing to organise in groups and follow rigid guidelines of intensive management, including maintaining monospecific and clean-weeded stands (Potter and Lee 1998; de Jong 1997).

The Ministry of Forestry developed several social forestry programmes in which farmers can obtain credits for establishing tree plantations on their fields, but they also have to form farmers groups. Another programme from the same ministry is the re-greening programme that provides funds and material for one year to plant trees on farmers' land and for two years for maintenance. However, farmers obtain no rights to the trees or the land. A more recent programme directed specifically at stabilising swidden agriculture is the Land Use Stabilisation programme aimed at converting upland swiddens to permanent rubber and fruit tree lots. Under this programme farmers receive a hoe, planting material and fertilisers and obtain rights to a 0.5 ha lot.

Programmes directed at establishing timber and pulp plantations and oil palm plantation probably have more influence on swidden agriculture and swidden fallow secondary forest management. Indonesia has an ambitious industrial timber programme to develop its pulp and paper industry. At one point there were plans to develop 4.5 M ha of pulpwood plantations by the year 2000, a target that has not been achieved. Timber companies often used coercive measures to acquire the land needed for the timber plantations (de Jong 1997). New approaches are being tested that involve smallholders in the production of fast-growing species (Potter and Lee 1998).

Programmes to develop oil palm started in the 1980s. The early projects followed Nuclear Estate Programmes in which para-state companies developed oil palm estates, but between 60-80% of the area was managed by farmers in smallholdings. Participating farmers gave up much of their swidden fallow land to receive facilities to produce oil palm on 2 ha. Subsequent programmes focused more on establishing such schemes for transmigrants and involving private companies. These companies must provide the funds to develop Nucleus Estate Smallholder production involving transmigrants, while swidden agriculturists provide the land. Especially during 1998 and 1999 private investors and provincial governments favoured oil palm estates over the older smallholder tree planting schemes, a trend that is likely to continue in the future.

The smallholder tree crop development schemes have succeeded in promoting the use of improved germplasm for some crops such as rubber. In general their influence has been minimal, partly because these schemes occur mainly in remote areas where none of the larger estate crop development programmes take place such that they do not infringe on the latter. In addition, in provinces like Jambi, many smallholders preferred to acquire planting material from private nurseries, rather than sign up for government programmes (Potter and Lee 1998). Of more influence have been the large-scale tree planting schemes, as they largely replace swidden agriculture. This has had a negative impact on a relatively benign swidden agricultural landscape including swidden fallow secondary forest, secondary forest gardens and forest remnants. For instance, in 1990 Jambi was described as a province that was still environmentally rich, because development had been based on smallholder rubber expansion, rather than on large estate development. One decade later this picture has changed as a result of industrial timber production and oil palm development (Potter and Lee 1998). Potter and Lee (1998) and de Jong (1997) have questioned the social and economic benefits that the industrial timber and the oil palm development schemes bring to participating smallholders.

6. CONCLUSIONS

Although there is evidence that swidden agriculture is not the largest cause of conversion of primary forest in Indonesia, there is without doubt an extensive area of secondary forest related to this type of land use in the country. Exact figures of this area are lacking, but much of the current area of swidden fallow secondary forest is subject to processes of change, a result of land pressure caused by population growth of swidden farmer groups. Additional factors of change are government programmes like estate crop development, industrial tree plantations and transmigration. The processes of change already resulted in decreasing dependency on swidden agriculture in several of the regions of the country, while further change leads to a progressive incorporation of tree cropping in the management of secondary forests. Where this happens, secondary forest gardens or more intensive smallholder plantations become an important component of the land use, while the swidden component increasingly disappears. Gradually these systems develop into smallholder tree crop production (de Jong 2001a; b).

It is possible to identify several factors that contributed to the development of tree cropping based agriculture, rather than intensified production of annual or semi-annual crops, or conversion of secondary forests into grassland for cattle production. These are:

- a culture of tree and forest management in many parts of the country,
- a history of estate tree crop production introduced by the Dutch which introduced tree species and the economic infrastructure that facilitated smallholder tree crop production, and
- an ecological setting that made large scale cattle ranching less feasible, as it would have resulted in widespread low productivity *Imperata* grasslands.

The previous discussion indicates the pivotal role that fallow classification and management plays in the agriculture-forest management complex of *Bidayuh* swidden agriculturists in West Kalimantan. In swidden agricultural systems trees usually are planted, or started to be protected during the swidden stage or, possibly more often, during the fallow phase of agricultural fields. This chapter shows that among *Bidayuh* farmers tree planting in fallow is not an ad hoc decision, but is carefully related to future land-use options of agricultural fields. This adds a new weight to the importance of SFSF, which so far has been recognized mainly for its role of soil fertility restoration (e.g. Smith *et al.* 1999), and as a resource of a large number of products that are used for daily consumption. To this function a third one needs to be added. Fallow fields are the initial phase of forestry production, a type of land-use that is now widely recognized to be common among many swidden agriculturists. Beside the intermittent phase between different cycles of crop production, fallow fields are also the crucial intermediary between crop production and forestry production of fields.

The precise role of the factors that affect the direction of change need to be specified more accurately, as they will allow prediction of the circumstances under which transformation of the swidden-fallow agricultural into more managed forests dominated production, be it extensive secondary forest gardens, or more intensive small holder tree plantations. This will then enable formulation of policies to stimulate such transformation, where considered appropriate. The net result may be land use development at lower economic, social, and environmental costs than other development options like oil palm estates, industrial timber production or degradation. Probably the most important conclusion that can be drawn from this chapter is that swidden agriculture and the related management of secondary forest can be looked at as an early step in a progressively intensified land use. Under the right circumstances swidden agriculture may develop into a land use that has a larger component of secondary forest gardens, agroforests, or tree cropping, with associated benefits.

CHAPTER 6
THE IMPACT OF RUBBER ON THE FOREST LANDSCAPE OF BORNEO[1]

1. INTRODUCTION

Rubber is the most widespread smallholder tree crop in Southeast Asia. Although initially large estates planted the bulk of the region's rubber, smallholders soon captured most of the production. Currently, Indonesia's rubber plantations cover 3.4 million ha, of which smallholders account for more than 75% (BPS 1999). In peninsular Malaysia the area in rubber has declined since the 1970s, but rubber remains the second most common tree crop in terms of area, with 1.5 million ha in 1990 (Vincent *et al.* 1997). Large estates produce much of Malaysia's rubber, but smallholders dominate rubber production in the State of Sarawak (Cramb 1988).

Some analysts blame the expansion of rubber for greatly contributing to the conversion of mature tropical forest in both Indonesia and Malaysia (Vincent and Hadi 1993). This chapter critically examines to what extent smallholder rubber production actually led to forest conversion in West Kalimantan (Indonesia) and neighbouring Sarawak (Malaysia). Although the chapter will not discuss either Sumatra or mainland Malaysia in detail, it appears that parts of these regions went through similar processes (Angelsen 1995; Vincent and Yusuf 1993).

This chapter presents two main arguments. First, as long as there was low pressure for land, swidden fallow farmers who grew rice could easily incorporate rubber into the fallow component of their production systems. The introduction of rubber did not lead to encroachment into primary forest, nor did it greatly affect the broader forest landscape, comprised of primary forest, secondary forest, and forest gardens. Evidence from the adoption of rubber by *Iban* Dayak in the Second Division of Sarawak and by the *Kantu* Dayak in the eastern part of West Kalimantan support this argument. The *Iban* case and two other cases presented below suggest that in areas where land pressure became important long after rubber was introduced, local respect for forest remnants and authorities constrained the expansion of agricultural land into unclaimed forests. As a result, rubber production did affect the amount of fallow (secondary) forest in the landscape, but not the remaining primary forest. Rubber gardens basically replaced swidden fallows.

[1] A revised version of this chapter has been published as: When new technologies meet traditional forest management: The impact of rubber cultivation on the forest landscape in Borneo. Chapter 20: 367-381in: Arild Angelsen and D. Kaimowitz (eds.) The impact of technological change in agricultural change on deforestation. CAB International; 2001.

Second, the chapter argues that the introduction of rubber by swidden agriculturists actually had a positive effect on reforestation and therefore on the total forest landscape. Many farmers combine conversion of tropical forests for agriculture with the active creation of forests, such as structurally complex and floristically diverse forest gardens (de Jong 1995b; Padoch and Peters 1993). We develop this argument using evidence on rubber's impact in three *Bidayuh* Dayak villages in West Kalimantan. In particular, we look at the expansion of managed forests in the subdistrict of Noyan (de Jong 1995b) and forest management in the sub-district of Batang Tarah (Padoch and Peters 1993) and in Sinkawang (Peluso 1990).

The chapter first summarises how rubber arrived in Malaysia and Indonesia. Section three discusses why swidden farmers easily adopted rubber and the effect this had on the forest landscape. Section four demonstrates rubber's contribution to traditional reforestation practices. Section five draws general conclusions from the cases discussed.

2. RUBBER IN INDONESIA AND MALAYSIA

2.1 The arrival of rubber

Rubber was first introduced in Borneo at the beginning of the 20th century and expanded rapidly. Table 6.1 gives data on the expansion of rubber in the region. By 1921, area grown in Southeast Asia had reached 1.6 million has and smallholders already accounted for one third of that (van Hall and van de Koppel 1950). The crop expanded in a parallel fashion in Sarawak and West Kalimantan. Of the 86,000 ha produced in Sarawak in 1930, smallholders grew 90 %. In 1924, exports from West Kalimantan (then Dutch Borneo) reached 15,247 tons, implying an area of between 40,000 and 100,000 ha (Uljée 1925).

Table 6.1 Historical development of rubber in Borneo

Year	Region	Area (ha)	Production (tonnes)
1910	All of Southeast Asia	500,000	
1921	All of Southeast Asia	1,600,000	
1911	West Kalimantan	500-1,000	128
1924	West Kalimantan	40,000-100,000	15,247
1930	Sarawak	30,000	
1940	Sarawak	97,000	
1961	Sarawak	148,000	
1960	Second Division	25,000	50,000
1971	Second Division	36,000	19,000

Composed from Uljée (1925), Hall and Koppel (1950) and Cramb (1988)

The rate of rubber's expansion fluctuated over time. In 1912, the territory now called Indonesia (then Dutch East Indies) had the world's second largest area of rubber plantations after Malaysia (then referred to as British Malaya) (van Hall and van de Koppel 1950). High rubber prices in the mid-1920s, resulting largely from restrictions on the international rubber trade associated with the "Stevenson Reduction Scheme", led to rapid expansion in production (Ishikawa 1998; McHale 1967). However, by the end of the decade expanding rubber production in the Dutch East Indies had depressed world prices, which remained low during the early 1930s (McHale 1967). In 1934, both the Dutch East Indies and Sarawak joined the International Rubber Regulation Agreement (IRRA), which severely limited the expansion of rubber. The agreement established a coupon system that restricted how much rubber producers could sell and traders could buy. This especially affected smallholders (Barlow 1978; van Hall and van de Koppel 1950; McHale 1967). Prices boomed again in 1950-51, leading to a new surge in rubber planting and tapping in Sarawak (Cramb 1988) and probably in West Kalimantan as well.

Between 1960 and 1971, rubber exports from Sarawak gradually declined from 50,000 tons to 19,000 tons. Interest in replanting among small farmers declined, but thanks to a government Rubber Planting Scheme, total area increased from 25,000 ha to 36,000 ha in 1971. The scheme provided cash advances to farmers who established new rubber gardens. Between 1971 and 1977, when the scheme was temporarily halted, no new planting took place. During this period, pepper also became a prominent cash crop. In subsequent years, farmers have shifted their primary focus back and forth between pepper, rubber, and off-farm work (Cramb 1988).

Coastal Chinese and Malay farmers initially planted most of the rubber in West Kalimantan (Dove 1993b). In the 1930s, inland Dayak swidden agriculturists widely adopted the crop. This may seem surprising given the colonial restrictions on rubber expansion at the time. But apparently many traders from Sarawak were able to obtain extra coupons despite the restrictions and used them to buy cheaper rubber from Dutch Borneo. Smuggling rubber from Dutch Borneo to Sarawak was common (Ishikawa 1998) and remains so to this day. All rubber officially exported from West Kalimantan came out of Pontianak, the provincial capital. Since no good roads connected the province's remote Dayak villages to the capital the only way villages' inhabitants could sell their rubber was to send it to Sarawak. This situation continued until better roads finally connected most of West Kalimantan to Pontianak during the early 1980s. Since that time, the Dayaks have sold all of the rubber they produce in the provincial capital. This has made rubber production more attractive and led farmers to plant more rubber.

3. ADOPTION OF RUBBER IN SWIDDEN AGRICULTURAL SYSTEMS

Several authors (Cramb 1988; Dove 1993b; Gouyon *et al.* 1993) point out that rubber production fitted the Dayak farmers' traditional swidden agriculture systems well. In the prevailing swidden systems in Borneo, each year farmers slash and burn a field and plant rice. They may also plant small amounts of other crops or tree species just prior to, together with, or shortly after planting rice. Once they harvest the rice at the end of the year, they devote less labour to the field. If they planted manioc there they will still come back the following year to harvest. They also harvest fruit species and may continue to plant additional fruit trees during the following years. However, after the third year or so, the field gradually reverts into a secondary forest, with or without any planted trees. If the field contains many planted or tended trees, farmers will gradually start to clear around them. Otherwise, they will convert the field into a swidden again once the fallow vegetation has developed sufficiently.

Rubber fits nicely into the swidden system. Farmers can plant it during the swidden stage, often before rice is planted, and then leave it virtually unattended until the trees are large enough to tap, about ten years later. Cramb (1988) portrays rubber gardens as simply managed fallows that make the swidden fallow cycle more productive. Farmers were already familiar with the low labour-input technique required to establish tree crops in fallow areas as they had used them to cultivate indigenous tree-crops such as fruit, illipe nut, and gutta percha (Cramb 1988; de Jong 1995b; Padoch & Peters 1993). Rubber's seasonal labour demands complement those of rice cultivation. Farmers cultivate rice during the rainy season, while rubber is fairly flexible and provides work and income during the dry season. Farmers can easily dispose of the output of rubber, which provides a regular source of cash. Although rubber has a quite low ratio of value to weight, it can be stored for long periods and marketed when convenient. For many swidden fallow farmers rubber constitutes their main source of cash. Moreover, rubber provides a convenient bank account that can be tapped – literally - as the needs arise, for example, in periods of natural and economic shocks.[2]

4. INCORPORATING RUBBER IN THE SWIDDEN FALLOW CYCLE

4.1 Rubber among the Iban in Sarawak's Second Division

This section discusses two cases where upland rice farmers in Borneo incorporated rubber into their swidden fallow cycle: the case of the Iban Dayak farmers in Sarawak's Second Division (Cramb 1988) and that of the Kantu Dayak farmers in the village of Tikul Batu, in eastern West Kalimantan (Dove 1993b).

The Iban Dayak arrived in Sarawak's Second Division in the 16th century. During the next 200 years they converted most of the original primary forest into secondary

[2] A recent CIFOR study documents a sharp increase in rubber planting during the recent economic crisis in Indonesia, including West Kalimantan. The future income security and flexibility rubber provides are probably among the main reasons why farmers planted rubber in the midst of the crisis (Sunderlin *et al.,* 2000).

forest, leaving only remnants of primary forest (Cramb 1988). They farmed their swidden fields for one year and then left them in fallow for an average of 15 to 20 years. This was well beyond the minimum fallow period required to restore the nutrient content in the vegetation and avoid excessive weed invasion after slashing, which was about seven years. Before they started growing rubber around 1910, the Iban had been growing coffee and pepper commercially for around a decade. The Sarawak government heavily promoted smallholder rubber production and the Iban took up the activity with enthusiasm. Initially, only wealthy communities could afford the plantation costs, at that time equal to about 750 kg of rice per ha. Once rubber gardens were more widely established, however, seeds and seedlings became cheaper and just about any interested household could plant the new crop. After rubber's initial expansion, planting continued more or less progressively, even during periods of low prices or trade restrictions such as the 1920s (Cramb 1988; Ishikawa 1998).

The introduction of rubber led farmers to reduce their fallow periods and begin planting three to four consecutive rice crops, after which they would plant rubber and leave it there for many decades. This led to higher pressure on the remaining fallow land, but did not transform the forest landscape much. Similar areas of land remained under tree cover. As traditional rubber gardens are rich in plant species, there may have been little impact on species diversity (de Foresta 1992; Rosnani 1996). Farmers converted some of their previous fallow land into rubber gardens, but these contained a large amount of secondary vegetation that developed together with the rubber. The age distribution of fields with secondary forest or rubber gardens that included secondary vegetation may have shifted, but the total forest landscape probably did not change much, nor did encroachment into primary forest accelerate.

During the 1930s, reports emerged that excessive rubber planting had caused shortages of land for rice. While some areas did experience shortages, they were isolated cases where households had only one or two hectares of rubber, mainly planted on land that was not suited for rice in any case. The cultural importance of rice kept people from planting rubber on fallow land where they could produce rice again.

Cramb (1988) suggests that by the time rice land became scarce governments were able to monitor the expansion of agricultural land and to keep farmers from clearing primary forest without permission. The government widely announced that farmers could not expand their agricultural holdings into un-cleared forest. Visits of government officials to villages were probably at least partially effective in enforcing these measures.

In the decades following World War II, population growth increased the pressure on remaining fallow land. Farmers were forced to rely more on cash crops and devote less land to growing rice. Price booms boosted rubber planting, but farmers did not respond to periods of low prices in a symmetric fashion; they kept the rubber gardens. By 1960, rubber covered half of the entire territory in some Iban villages in the Second Division, and the villages had ceased to be self-sufficient in rice. Some people preferred rubber and only produced rice when they felt they had enough land to do both. Others looked for off-farm income or migrated to remote areas. By the 1980s, many Iban rubber gardens in the Second Division had gone through at least two rice-rubber cycles and hill rice farming had become only a supplementary activity for most farmers (Cramb 1998). The province of Riau in Sumatra went through a similar process (Angelsen 1995).

In the Iban case, by the time rubber became the dominant crop, farmers had stopped expanding into primary forest and swidden fallow land had already expanded a great deal. Additionally, government prohibitions on converting primary forest limited further encroachment into primary forest areas. Had this not been the case, swidden cultivation might have expanded more and rubber could have played a role in that. The government in Sarawak did not consider secondary forest off limits and did not restrict rubber from replacing it.

4.2 Rubber among the Kantu in eastern West Kalimantan

The *Kantu* in central West Kalimantan underwent a process similar to the one just described. The *Kantu* received their first rubber seeds from their *Iban* neighbours, living in Sarawak's Second Divison. By World War II, the majority of farmers reportedly had rubber, but few had full-grown rubber gardens. In the mid 1980s, an average *Kantu* household had two dozen plots on 52 ha of land, of which two or three plots were used each year to produce rice and an average of five plots or 4.6 ha was in rubber. Although this was mainly on land that farmers had once used for swiddens, the land was of poor quality and therefore had little value within the swidden system. These sites are, for instance, located along the riverbanks or on poor heath soils. Today rubber is the principal cash income among the *Kantu*, and complements non-monetary incomes from agriculture and forest collection.

At least until the late 1980s, rubber gardens had no significant effect on agricultural expansion into the forests (Dove 1993b). Apparently, as in the *Iban* case, the *Kantu* have enough fallow land where they could plant rubber that they did not need to convert primary forest. Some of that land is of poor quality and farmers are willing to take it out of the rice production cycle. Given the abundance of fallow land, they could put some land aside to grow rubber without drastically reducing the length of the fallow and thereby rice yields.

The *Kantu* swidden agricultural labour system was apparently flexible enough to allow farmers to allocate some of their time to rubber tapping and occasional weeding of rubber gardens without significantly affecting their other main economic activities. They do not devote labour they would otherwise allocate to cultivating rice to produce rubber. Most of the time they spend on rubber production would probably otherwise go into activities such as hunting, forest product collecting, house maintenance, or leisure.

5. RUBBER AS AN AGENT OF FOREST RECONSTRUCTION

The introduction of rubber has not only affected the clearing of forest by Dayak farmers but also their reforestation activities. Elsewhere, we have argued that while Dayak farmers throughout Borneo convert some forested land into agricultural land they also transform other non-forested land back into forest (de Jong 1997). Many of these human-made forests are similar in structure and diversity to the original primary forest (de Jong 1995b; 1999, see also Chapter Seven). This section discusses three cases to show the impact of rubber in this process; all of which involve *Bidayuh* villages. It goes into greatest detail in the case of Ngira (see Chapter Two). It also makes reference to the village of Tae, 150 km south-west of Ngira, occupied by *Jangkang* Dayak, and to Bagak, a village located much closer to the coast, near the border between West Kalimantan and Sarawak (Padoch and Peters 1993; Padoch *et al.* 1998, Peluso 1990).

5.1 Rubber in Ngira

The village of Ngira in 1994 had a population density of 14/km^2. Farmers in Ngira first adopted rubber production during the mid-nineteen thirties. Much rubber was exported to Malaysia, since the road to Pontianak was very poor. As late as 1980, even though many farmers had rubber fields, rubber still occupied only a small portion of the land. Road improvements that made the region more accessible changed this situation. Farmers became more integrated into the cash economy and began to consume more goods from outside the region. Rubber is now the main cash crop and many of the current rubber gardens were planted during the last twenty years. Hence, to a certain extent the village's rubber expansion remains fairly recent compared to the coastal regions in West Kalimantan or the Second Division in Sarawak.

Villagers grow rubber both in rubber gardens and in *tembawang*. The evolution of Ngira's forest landscape between 1984 and 1993 clearly indicates that introducing rubber can have a positive effect on land-use. In 1994, the village had 1,688 ha that had been slashed for swidden production at one point or another (Figure 6.1). A small part of this was currently under swidden production (125 ha). More than half of it was in fallow (954 ha). There were 95 ha of full-grown *tembawang* forest, much of it with rubber inside. Rubber gardens covered 344 ha, of which 121 had planted within the last ten years. An additional 251 ha of fallow land had rubber planted on it but since the trees were still small, the land was classified as fallow rather than rubber garden. In total, 692 ha had planted tree vegetation, 40% of the total cultivated land.

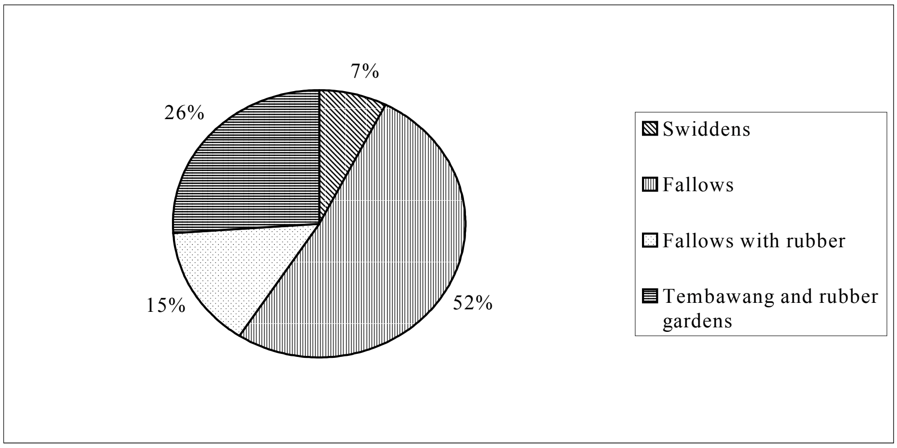


Figure 6.1 Land use patterns in Ngira, West Kalimantan in 1994

Of the 692 ha planted with trees, 280 ha had either a mixture of rubber, fruit and other trees or fruit trees and other species. Most of these areas were adjacent to *tembawang* areas, since villagers prefer to keep their rubber gardens close to the village. This is because they tap the rubber in the morning and collect the latex just before noon. If the villagers ultimately decide to allow abundant secondary regrowth in those fields, which appears likely, they will end up creating an additional 280 ha of *tembawang*.

In total, we calculated that 512 ha of land was replanted with trees during the last ten years to create *tembawang* or mixed rubber gardens, which combine rubber, other planted species, and spontaneous vegetation (de Foresta 1992; Rosnani 1996). In that same period, farmers converted only 360 ha from natural forest to agricultural land. Moreover, this increase in effective forest cover took place at the same time as population grew annually by 2.9%.

The data suggest that introducing rubber into Ngira greatly contributed to the reforestation just described. It encouraged the expansion of forest gardens and the transformation of swidden fallows into rubber forests. The next two cases provide some indication of how this type of process might play out in the long run.

5.2 Rubber in Tae and Bagak

In both Tae and Bagak, the adoption of rubber has resulted in the sustained presence of forests. Tae is a village located in the sub-district of Batang Tara, about 150 km southwest of Ngira, and has a population density of about 80 people/km^2. People use motorbikes on a well-kept dirt road to take valuable durian fruits (*Durio zibethinus*) to traders that come from Sarawak (Padoch and Peters 1993). Many farmers have turned to wet rice cultivation in permanent paddy fields, while maintaining some upland swiddens and rubber gardens. Only the peaks of the highest mountains still have unclaimed primary forest, although significant areas of communal primary forest protected by the communities and *tembawang* remain.

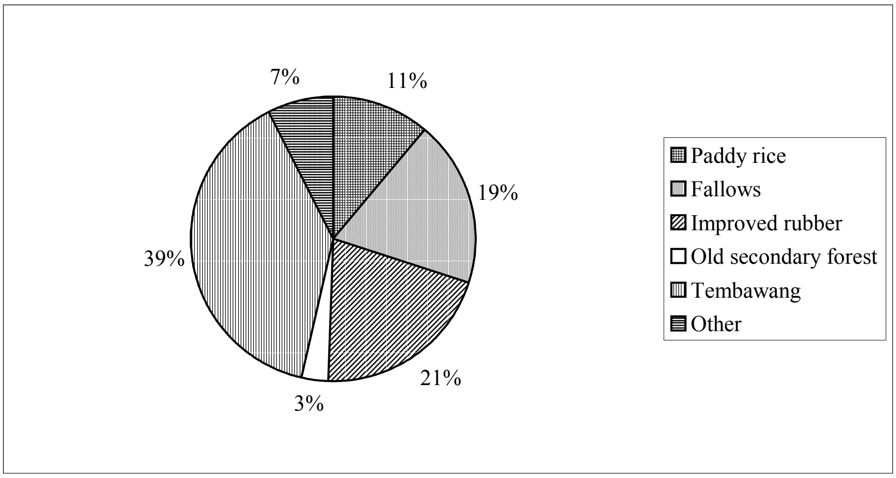


Figure 6.2 Land use patterns in Bagak, West Kalimantan (adapted from Peluso 1990)

Bagak, a Dayak village located along the northern coast of West Kalimantan, near Singkawang, represents another example. It has a population density of 120 people/km^2. It is strictly forbidden to open new fields onto the Gunung Raya Pasir nature reserve that borders the village territory even though the village has no other remaining areas of natural forest it could convert to agriculture (Peluso 1990). In 1990, 11% of the 1,800 ha of cultivated land in the village was under paddy rice and 19% under swiddens and swidden fallows. Another 16% of the area consisted of improved rubber plantation, established in 1981 and 1982, while 39% of the land was under mixed tree cover, similar to *tembawang*. Secondary forests preserved by the community accounted for another 3%. (See figure 6.2.)

These last two cases indicate that the presence of the forests tends to stabilise when swidden fallow and forest management reaches at an advanced state of land use. Respect for individual ownership of forest gardens, communal protection of forest remnants, and agreements between communities and governments to preserve protected areas largely explain this tendency of forest area to stabilise. Table 6.2 summarises the main characteristics of the five cases discussed.

Table 6.2 General characteristics of the five cases presented in this chapter

Attribute	**Second division, Sarawak**	**West Kalimantan**	**Ngira**	**Tae**	**Bagak**
Ethnic Group	Iban	Kantu	Bidayuh (Maté-maté)	Bidayuh (Jangkang)	Bidayuh
Year rubber introduced	1910s	1940s	1930s	1930s	1930s
Population density	Not available	Not available	11 person/km^2	80 person/km^2	110 person/km^2
Accessibility	Good	Poor	Poor	Regular	Good
Stage of development	Rice cultivation being abandoned because of land pressure. Rubber replaced fallow land. But much rubber also being abandoned	Rubber incorporated into swidden fallow cycle. Still little impact of rubber on general land use	Rubber fully incorporated into swidden agricultural cycle. Rubber boosts expansions of forest gardens	Rubber stable part of land use. Upland agricultural fields increasingly converted to mixed rubber fields. Rice production converted to irrigated fields. No further encroachment into forest area	All stages of forests and tree vegetation, including rubber have stabilised. No further encroachment into forest area
Key factors that influence impact of rubber technology on forest landscape	Population pressure; government control; abandoning of rubber gardens	Incorporation of technology in extensive land cultivation	Increased cash production; existing forest management technology	Local customs related to forest ownership; communal management of forest reserves	Local customs related to forest ownership; communal management of forest reserves; control of protected area

6. THE EFFECT OF RUBBER-LIKE TECHNOLOGIES ON FOREST LANDSCAPES

In several of the cases discussed above introducing rubber had the following effects on forest clearing: At the time rubber was first introduced, farmers already had substantial areas of fallow and only planted a small portion of it with rubber. They mostly planted rubber on land that was not vital for rice production either because they had enough other land to grow their rice or because the rubber land was of poor quality. Subsequently, further planting of rubber in fallows coincided with population growth and increased pressure on land. Farmers no longer had enough land to sustain swidden rice production and remain self-sufficient in rice. This led them to seek alternative sources of income, either cash cropping or off-farm employment. While the expansion of rubber appears to have accelerated the abandonment of rice self-sufficiency it probably did not result in forest encroachment. Rather than clear additional forests to plant rice, most farmers chose to take up off-farm employment or obtain income through other means. Partly this happened because the government has in some cases been able to persuade communities to stop expansion of agricultural land into the remaining primary forest areas.

In some areas of West Kalimantan the introduction of rubber seems to have actually increased forest cover. In Ngira, the expansion of *tembawang* and rubber gardens appears to have offset forest encroachment for agriculture between 1984 and 1993. The existing forest management practices can easily incorporate rubber and rubber actually appears to have stimulated the expansion of these man-made forests, which have a diverse structure and floristic composition. On balance rubber appears to have increased in total forest cover in this area. The cases of Tae and Bagak suggest that eventually the process of forest transformation reported in Ngira will stabilise and lead to a mixture of agricultural land, mixed rubber gardens and forest gardens, and primary forest, which villagers and the government do not allow farmers to convert to other uses.

One can draw several general conclusions from these cases. At the time rubber was introduced into the pre-existing extensive land use system, significant areas of primary forest had already been converted for agricultural use. This made it possible to incorporate rubber without creating a significant demand for new land from primary forest. Rubber did not require much additional labour and the labour it did required was largely during periods when it was not needed by other agricultural activities. Farmers had little need for cash and adjusted their level of effort to what was required to meet that need (Dove 1993b). They maintained yearly swiddens as long as that was politically feasible and there was sufficient land for new swiddens. The fact that they continued to grow rice also reflected their cultural preference to produce their principal staple in their own private fields.

Once population density increased the pressure for land limited farmers' flexibility. They maintained their rubber gardens, but gradually stopped cultivating rice. In three of the five cases discussed, local and / or national authorities increasingly circumscribed encroachment on additional forest areas. Pressure from within the communities to preserve the remaining forests increased and governments persuaded farmers to stop further encroachment. Simultaneously, the state and its local representatives increased their presence. In West Kalimantan, like in many other places in the world, the laws largely prohibit farmers from encroaching on forests. However, such rules only became relevant once the government had sufficient presence to enforce them.

The introduction of a new cash based production system coincided with and was a catalyst for a number of cultural and socio-political changes, including the increased presence of the state. The rising importance of cash based economic transactions and improved infrastructure allowed for better communication between state officials and communities. Officials at the regional level adopted national concerns about forest encroachment, and that facilitated enforcement of forest regulations.

Lastly, the cases discussed above demonstrate that new technologies involving some kind of tree or forest production may contribute to reforestation. The presence of tree crops also influences what happens to the forest landscape when other changes occur in local agricultural systems and demographic patterns. For example, land already under tree vegetation is much more likely to revert to forest when farmers shift from upland rice to wet rice cultivation or migrate to the cities. This is taking place in West Kalimantan in areas with out-migration from rural areas. One observes many old *tembawang* and rubber gardens that have developed into closed dense forests.

Tree planting technologies, like rubber production, have a low impact on the forest landscape when they are incorporated into long-existing extensive agricultural systems. However, when population pressure and market integration increase alongside each other, these effects change. When these technologies are introduced at an early stage in a resource use continuum from extensive to more intensive land use, socio-economic progress allows for a consensus on land use that preserves forests. This may offset negative effects that otherwise may have been caused by the impact of the technology under changing conditions like for instance increased land pressure caused by higher population densities. Tree planting technologies may be incorporated in local forest management practices and subsequently have a positive effect on the forest landscape.

These findings suggest important policy recommendations. In general, tree technologies have significant advantages when trying to improve local agriculture. Before promoting new technologies policymakers should take into account the degree of government presence and negotiations with communities over preservations of certain areas. The promotion of new technologies should always be considered in the light of local resource (forest) management practices, to obtain positive synergies and achieve an outcome acceptable to local farmers and national authorities, as well as limiting negative environmental impacts.

7. CONCLUSIONS

The introduction of rubber in West Kalimantan contributed little to encroachment into primary forest. On the other hand, it apparently favoured the restoration of forests in areas where land use became less intensive. It needs to be emphasised, however, that specific conditions in the local context allowed this to take place. If, for example, adoption of rubber had been accompanied by substantial migration into rural areas that would probably have resulted in encroachment into forest areas. This has happened in places in Sumatra. The impact of a new agricultural technology on forest conversion depends on the technology itself, but also on the economic and socio-political circumstances in which it happens. In addition, the impact changes over time, in part as a result of parallel economic and socio-political changes.

Tree technologies should be preferred when trying to improve local agriculture. Policymakers should consider the degree of government presence and negotiated agreements concerning forest conservation before promoting new technologies in forested regions. Incorporation of local resource management technologies, especially tree planting or forest management technologies, may enhance positive outcomes in terms of increased income and forest preservation.

CHAPTER 7
STRUCTURE AND FLORISTICS OF MANAGED FORESTS

1. INTRODUCTION

This chapter investigates the structure and floristic composition of *tembawang* and compares them with mature natural forests like forests islands (*pulau rimba*) and communal forest reserves (*hutan tutupan*). *Tembawang* and rubber gardens are the principal types of "reconstructed forests" in Ngira, Koli and Teriang, the three villages where the research on Dayak forest management took place (see Chapter Two). Rosnani (1996) investigated the floristic composition and structure of rubber gardens. Forests are characterised by a certain structure and species composition. Although these two characteristics are only part of the complexity of forest vegetation, it can be stated that forests with a structure and species composition closer to mature natural forests are better equipped to fulfil the functions of the latter. Such forests are a better alternative, from a conservation and ecological viewpoint, than forests with a less well developed structure and composition.

Usually, *tembawang* contain a high density of domesticated and non-domesticated fruit trees. These fruit trees may be planted on land that was previously used for agriculture, but they may also be planted directly in natural forest. Many other useful non-fruit species are also planted in *tembawang*, for instance bamboo, ironwood (*Eusideroxylon zwageri*), or several other meranti (Dipterocarpaceae) species. In *tembawang* a large number of naturally occurring species are tended and others are merely tolerated. Single *tembawang* are usually about 1 to 2 ha large. Since many farmers in a single village have *tembawang*, their total area may be quite large. *Tembawang* are privately owned and inherited by descendants of the person who established these forests. This ownership is highly respected. In locations where there is no natural forest anymore, large stretches of *tembawang* still remain. (See also Chapter Four.)

2. STUDYING FLORISTICS AND STRUCTURE OF MANAGED FORESTS

In this chapter data will be compared from inventories of five different *tembawang* with those of two plots made in *pulau rimba* all located within the boundaries of Ngira. As explained in Chapter Four, *pulau rimba* are small areas of mature natural forests, of one to four ha, for which a farmer has gained the sole right to use the land because he surrounded this patch with his swiddens and fallows. Farmers protect *pulau rimba* as a source of forest products, especially construction materials, but also rattans, honey and others. Farmers may actually tend trees in *pulau rimba* forests and plant rubber or other species since this enforces their exclusive use right to the forest resources. The two *pulau rimba* surveyed had not been subject to any such interventions yet. They constitute an appropriate point of reference which can be used here to compare *tembawang* and natural forests.

In the five *tembawang* and in the two *pulau rimba* contiguous 20 x 20 m^2 subplots were constructed to sample the vegetation. In three *tembawang*, and in the *pulau rimba* a total of 25 such subplots were constructed, representing a one hectare sampling. In one *tembawang* there was only sufficient space for 17 sample plots (0.68 ha) and in a third one only for 20 sample plots (0.8 ha). In each of the 20 x 20 m^2 subplots the dbh was measured, and the names recorded of all trees and lianas with dbh $\geq$ 10 cm (sample class I). In each subplot a smaller 5 x 5 m^2 subplot was randomly located to survey the plants with 2 cm $\leq$ dbh < 10 cm (sample class II), and dbh and species name recorded of each individual. At each of the corners of the 25 m^2 subplot a 1 x 1 m^2 subplot was constructed to sample the remaining vegetation (sample class III). Of individuals found in this smallest sample class the species name was recorded and the height measured. Initially species names were recorded with local names and subsequently herbarium specimens were collected. These specimens are deposited at the Herbarium Bogoriense, the Rijksherbarium Leiden, and the New York Botanical Garden. (See Chapter Four, Appendix 4.4.)

Tembawang can be managed in different ways, resulting in different silvicultural treatments, directly influencing species composition and structure. Following this section the specific silvicultural treatments that were applied in each of the five *tembawang* will be described briefly. This information will explain some of the variation in composition and structure of the different *tembawang* and allow some general conclusions regarding the type of *tembawang* management and the resulting forest type.

3. DESCRIPTION OF THE *TEMBAWANG* SURVEYED

The first *tembawang* studied, which had a size of 1.4 ha, was planted as a rice swidden in 1949. Trees were planted immediately after the rice was harvested; first fruit species, and later rubber. The rubber began to be tapped about 20 years after planting. In 1986 the owner cleared much of the undergrowth of the forest and planted coffee with the intention of producing a new cash crop. In 1992 a similar clearing was carried out and cacao was planted. Individual fruit trees are cleared from surrounding vegetation whenever they start yielding fruits.

The second *tembawang*, with an area of 1.7 ha, was slashed as a swidden in 1965. In this field trees were planted at a much slower pace. After the rice had been harvested, the field became covered with *Imperata cylindrica*. This *Imperata* grass, however, disappeared when fruit and rubber trees provide sufficient cover. The planting of trees has continued until today. Coffee was first planted in 1985 resulting in a heavy clearing of smaller trees. The field is now slash-weeded about 3 to 4 times per year. The owner plans to replace the coffee which does not produce well with cacao. Because of its younger age, and because more trees have been eliminated for the planting of coffee this second *tembawang* has a much more open vegetation than the first one.

The third *tembawang* of 1.6 ha was begun as a swidden in 1965, fruit trees being planted immediately after the harvesting of the rice. This is a large *tembawang* with a high closed forest. After the initial planting of fruit trees, few other cultivation activities appear to have been carried out. Notably, in this *tembawang* there are several very large ironwood trees, which are tended and harvested when needed.

The fourth t*embawang*, which has an area of 2.1 ha is located next to the river and the site floods easily. Her too, trees were planted immediately after the rice had been harvested. The field has also been planted with rubber, and more recently with coffee. The rubber is now being harvested, but the coffee has not been taken care of because the produce cannot be sold. A considerable part of the *tembawang* was recently slash-weeded to provide more room for fruit and rubber trees.

The fifth *tembawang*, with a total area of 1.2 ha, is located on the site of the first longhouse of the people of Ngira. The longhouse was built in 1932, and then relocated to the current village site in 1960. This *tembawang* has the most complicated ownership of those studied. Different families own different sections of this *tembawang*. Apparently no new planting has been carried out since the longhouse in this *tembawang* was abandoned

4. RESULTS

4.1 Tree densities

With the inventory data, the number of individual plants, basal area, and species densities per hectare were computed. A summary of these computations is presented in Table 7.1. The number of individuals and basal area are extrapolated to one hectare for those two *tembawang* in which the total sample area was less than 1 ha. This extrapolation was not done with this the number of species, since it cannot be assumed that this variable increases proportionally with an increase in sample size. Basal area was only computed for sampling class I and II.

The *pulau rimba* forests are similar in structure and plant-species diversity to other forests in Kalimantan. The two forests had 562 and 569 trees/ha of dbh $\geq$ 10cm. Similar studies in East Kalimantan reported tree densities of 541 trees/ha (Kartawinata *et al.* 1981) and 445 trees/ha (Riswan 1987). From Malaysian Borneo a somewhat higher number of 672 trees/ha was reported (Wyatt-Smith 1966), whereas from Brunei 445 trees/ha were reported (Ashton 1964). Inventories from Amazonia report similar or somewhat higher numbers of trees per ha (Gentry 1988, Campbell *et al*. 1986).

Table 7.1 Structural and floristic characteristics of tembawang and pulau rimba

Feature	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
Number of trees							
SaCl I	429	281	443	408	569	562	568
SaCl II	2000	2768	3552	2688	2528	4464	3552
SaCl III	261200	54800	57700	222400	126300	108300	136000
Basal area/ha [m]							
SaCl I	26.78	22.20	32.46	15.15	23.17	38.17	56.81
SaCl II	2.49	4.40	4.97	3.40	3.84	6.19	5.15
Average diameter [cm]							
SaCl I	22.82	22.11	23.30	18.46	19.99	23.94	26.01
SaClII	3.62	3.83	3.77	3.61	3.91	3.78	3.81
Number species							
SaClI	70	55	121	79	79	147	150
SaClII	47	33	77	58	56	96	82
SaClIII	97	84	141	108	116	154	153
Total	150	122	231	165	183	254	258

Plots represent five tembawang (1 through 5) and two pulau rimba (6 and 7). Sample classes are I = individuals dbh > 10cm, Sample class II 2 < dbh < 10cm, Sample class III dbh < 2cm. (Number of species of plot 1 and 5 not extrapolated to one hectare, all other variables reflect one hectare sampling.)

The five *tembawang* had an average number of 426 trees/ha in sample class 1. This is somewhat lower than the 562 and 569 trees/ha of the two *pulau rimba* forests. The number of trees/ha did not differ very much in *tembawang* 1, 3 and 4. However, in *tembawang* 2 this number was significantly lower, 281 trees/ha. The low number of trees in this *tembawang* is a result of the clearing of forest vegetation to favour the coffee plantings. In *tembawang* 5 there were 569 trees/ha, a number equal to the second *pulau rimba* forest. This is a result of the many owners of this *tembawang* who expect to benefit from a small area of forests, and therefore plant more trees per unit area than they would usually do in other forests.

In the intermediate sample class (II) the two *pulau rimba* forests had 4008 individuals/ha, a number about two and a half times higher than the 1605 trees/ha reported by Riswan (1987) for mature natural forest in East Kalimantan. The five *tembawang* had only 2706 plant individuals/ha in this size class. The low density of trees in the intermediate sample class in the *tembawang* is a result of frequent clearings with the purpose of facilitating harvesting, or favouring planted or tended species. Only *tembawang* 3, in which very little clearing has been carried out since its planting, had the same number of individuals as *pulau rimba* 2 in this sample class.

In the smallest sample class (III) the two *pulau rimba* forests had 122,150 individuals/ha, again much higher than the 82,750 individuals/ha in the same size class reported from East Kalimantan (Riswan 1987). The five *tembawang* had an average of 144,480 plant individuals/ha in size class III. This value was substantially higher than for the two *pulau rimba* forests or the forests from East Kalimantan. Both high densities of species which frequently produce large quantities of fruits and periodical clearing of harvesting sites account for this. On the other hand, *tembawang* 2 and 3 had much lower values of plant individuals in the smallest sample class. In *tembawang* 2 this was the result of a very recent clearing of the forest to benefit the coffee plantings. The lower value of smaller trees in *tembawang* 3 could not be explained.

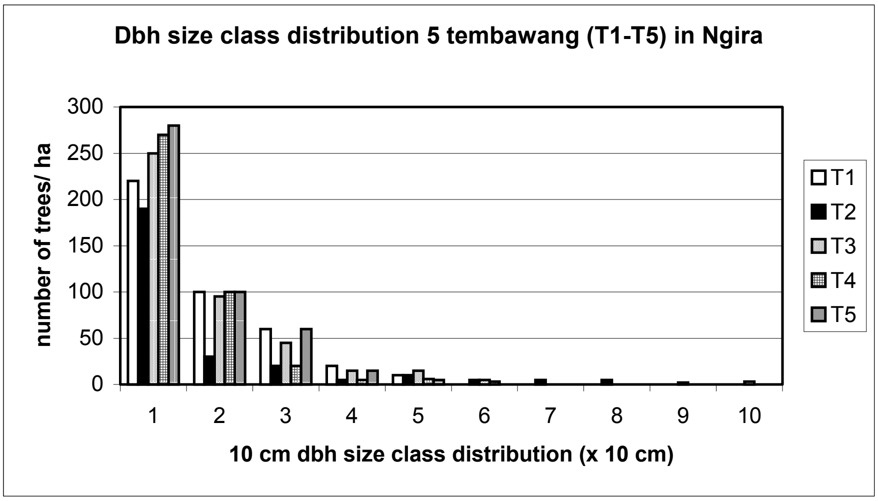
4.2 Basal area

Pulau rimba forest 1 had an average basal area of 38 m^2/ha, whereas *pulau rimba* 2 had a basal area of 57 m^2/ha. The basal area of the second *pulau rimba* is substantially higher than the 29.7 m^2/ha (Kartawinata *et al*. 1981) and 33.74 m^2/ha (Riswan 1987) reported from forest in East Kalimantan. The *tembawang* forests show a more constant divergence in basal area from the *pulau rimba*. None of the five *tembawang*, which had an average basal area of 23.8 m^2/ha, had a total basal area for trees of sample class I and II that exceeded the two *pulau rimba*. Only *tembawang* 3 had a basal area of trees dbh $\geq$ 10cm which approximated the value of *pulau rimba* forest 1. The lower basal area in the other *tembawang* is a consequence of both the lower number of trees/ha, and the lower average diameter of those trees (Table 7.1). Notably, *tembawang* 5, which had the same number of trees in this sample class as *pulau rimba* 1, had a much lower average dbh, and thus a much lower basal area.

In sample class II the basal area was 3.6 m^2/ha in the five *tembawang*, whereas it was 5.5 m^2/ha in the two *pulau rimba* forests. The difference resulted from the larger number of individuals in the two *pulau rimba* forests in this sample class.

4.3 Size class distribution

Structural differences between *tembawang* and *pulau rimba* forest can also be appreciated from diameter size class distribution of trees of sample class I. What immediately becomes evident from Figure 7.1, which displays graphically the size class distribution of the seven plots surveyed, are the presence of trees in each size class in *pulau rimba* forest 2. In *pulau rimba* 1, four of the larger size classes are empty, but up until size class 8 (trees 80 $\leq$ dbh < 90cm) the size class distributions are almost identical between the two *pulau rimba* forests. Only *tembawang* 3 has trees in size classes 9 and 15. In the other *tembawang* the largest trees are found in size class 8 or less. The size class distribution also shows how the five *tembawang* have fewer individuals in the intermediate size classes 4 -8.



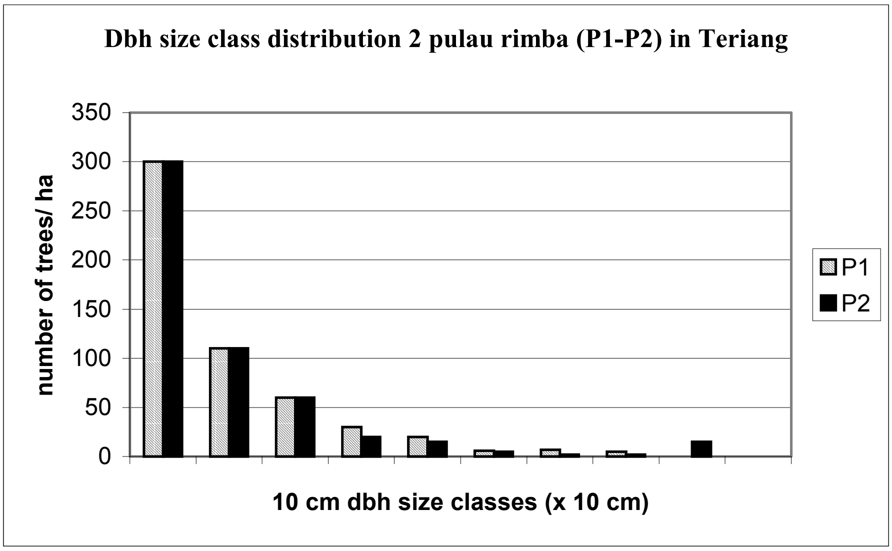


Figure 7.1 Diameter size class distribution in tembawang and pulau rimba in Ngira and Teriang

4.4 Floristics

Comparison of species diversity with other data is difficult since in most studies sample-plot size varies. From the species area curve in Riswan (1987: 454) it can be read that a one hectare plot had about 160 species of trees with dbh $\geq$ 10cm. In the two *pulau rimba* forest somewhat lower numbers of 147 and 150 species/ha were found. For Amazonia only Campbell *et al*. (1986) use one hectare sample plots. The

189 species/ha they found is also somewhat higher than in the two *pulau rimba* forests surveyed.

In the seven plots surveyed a total of 581 plant species was recorded. Table 7.1 shows the number of species for each plot surveyed, specified for each sample class. The average total number of species was 170 in the five *tembawang*, whereas the two *pulau rimba* forests had an average of 256 species. The largest number of species were found in *tembawang* 3, and this was consistent for the three different sample classes. This *tembawang* had only 23 species less than *pulau rimba* forest 1 and 27 less than *pulau rimba* forest 2. On the other hand, the second *tembawang* had less than half the number of species than the two *pulau rimba* forests.

Of the total of 581 species, 376 occurred in the *tembawang*, while 379 were recorded in the two *pulau rimba* forests. This means that 174 of the species that occurred in the *pulau rimba* forests also occurred in the *tembawang* (Table 7.2). It is remarkable that the large number of species, 202, which are found only in *tembawang*, but not in the *pulau rimba* forests. This is only three species less than the 205 species only found in the two *pulau rimba* forests. Of the 202 species found only in *tembawang*, 20 were cultivated species. Another 20 species were purposively tended, although they were actually native natural forest species. The remaining 162 were species that appeared spontaneously in the *tembawang* forests. Table 7.2 also shows that a larger number of species in sample class III was found only in *tembawang*.

Table 7.2 Shared and unshared species in one hectare plots of five tembawang and two pulau rimba forest islands

Sample class	**I**	**II**	**III**	**Total**
Species in common	78	56	110	174
Species in tembawang only	113	81	161	202
Species in pulau only	146	93	127	205

5. CONCLUSIONS

From the data presented above, it appears that *tembawang* are complex forests with structure and plant species diversity which can be almost equal to local mature natural forest. These are very encouraging findings and they indicate that such Dayak managed forests should be given more attention as forests which are worthwhile preserving or as possible indigenous reforestation methods. Preserving or increasing the area of *tembawang* will help reduce the negative effects of deforestation. However, there are several matters which need to be considered. Many of the species which were found in *tembawang* forests appear spontaneously. In the village where the research was carried out relatively much forest remained at close distance from the *tembawang*, providing ample sources of seeds of forest species. Furthermore, all the *tembawang* forests investigated were planted after only one cycle of rice cultivation. It is now becoming more common to plant *tembawang* on sites which have been used several times for agriculture (de Jong 1995b). It is to be expected that such forests will be less diverse than the ones described here.

Ownership of *tembawang* forests is highly respected, but also these forests are threatened as a result of population pressure and decreasing resources. In many locations in West Kalimantan *tembawang* which used to be owned by single descent groups are being divided up between family members (Claus 1991; Mayer 1998). Shared ownership inhibited the conversion of such forests for agriculture use. Now that *tembawang* are divided, and because good agricultural land is becoming scarce, more people are tempted to slash *tembawang* forests.

A solution to the problem of converting *tembawang* to agricultural land could be to make *tembawang* economically more profitable. In areas where population densities have exceeded certain levels, traditional rice swiddening will have to be adapted to solve the problem of land scarcity. Options are wet rice farming or some form of commercial agriculture. Managed forests like *tembawang* and *pulau rimba* do have a potential for market oriented smallholder forestry and thus can become part of the solution. Farmers already do produce cash-yielding species in *tembawang*. Elsewhere (de Jong 1993), we have argued that ironwood, but also several other species could be tended and harvested in *tembawang* and *pulau rimba* forests to supply the material for the production of shingles. However, increasing the interventions in managed forest does have its negative effect on the complexity and species diversity of forests. This becomes obvious if *tembawang* 2 and 3 are compared. *Tembawang* 2, in which coffee was planted, had in the sample class 1 only 63% of the trees of *tembawang* 3. In this size class it had only 46% of the species. Increased manipulation of *tembawang* forests will reduce the species present and therefore imply some loss of biodiversity.

CHAPTER 8
THE MANAGEMENT HONEY TREES[1]

1. INTRODUCTION

This chapter discusses two cases of honey procurement in the province of West Kalimantan, Indonesia. Both involve the same resource, i.e. honey from *Apis dorsata* bees. However, in each case this resource is handled differently, showing that local resource management practices may be very site specific. Any local resource management practices involve local technological knowledge, but also social behaviour, restrictions, and rules systems. The chapter will argue that such institutionalised resource management provides a sound basis for resource use that meets new challenges, such as achieving sustainable use or increasing monetary incomes. The possible practical implications depend on the particularities of each individual case.

The first case this chapter examines is honey tree management among *Bidauh* people, like the villagers in Ngira and Koli. In general, *Bidayuh* forest managers can own single honey trees that are inhabited by bees; they protect the trees and encourage bees to nest in them. The second case involves honey procurements by Malay who live in the Danau Sentarum lake area, in the district of Kapuas Hulu, about 250 km east of Ngira. Here, apiculturists assemble specially shaped boards that are popular nesting sites for *A. dorsata* bees. Once a swarm finds such a board, it continues to occupy the same board in successive years. Both Dayak and Malay beekeepers have an elaborate set of rules that regulate access to the trees and the nesting sites and impose fines for the breaking of such rules.

2. HONEY PRODUCTION IN WEST KALIMANTAN

Crane (1979) refers to honey as one of the oldest foods used by people. Four bee species of the genus *Apis* yield the majority of the honey consumed worldwide, although in the neotropics stingless native Meliponinae bees also produce significant quantities of honey. *Apis mellifera*, the most important honey bee, nest in small enclosures, like their close siblings, *A. cerana*. In comparison, *A. dorsata*, giant honey bees, and *A. florea*, little honey bees, build only single combs in the open. Mainly for this reason, the latter two species did not migrate to colder areas and are found only in the Asian tropics, where they have not achieved economic importance of *A. mellifera* and *A. cerana* (Crane 1979; Gojmerac 1980). *A. dorsata* inhabit areas from Pakistan to East Nusa Tenggara, Indonesia. In Indonesia they can be found in Sumatra (Riau, Lampung), South and West Kalimantan, South and

[1] An earlier and reduced version of this chapter has been published in Human Ecology 28(4): 2000.

Southeast Sulawesi, and Sumbawa. Their nests are up to 1 meter wide and are usually attached to the branches of trees (Rouquette 1994).

The indigenous Dayak of Kalimantan have collected, used and traded honey from *A. dorsata* bees for a long time. But they are not the only honey collectors on the island. Interior Malay groups, who often practice a lifestyle that is very similar to that of indigenous Dayak (Ishikawa 1998), also collect honey from *A. dorsata*. These Malay are descendents of Dayak who between the 16th and 18th centuries underwent a process of Islamisation following the coastal establishment of sultanates (King 1993) and became incorporated in Malay society. Both these groups have played an important role in the exploitation of products from the island's tropical forests. Traders from Asian and Western countries came looking for these products ever since they first reached that part of the world (Peluso 1983). Before the rise of the Indonesian timber industry in the early 1970s, the economic value of trade in non-timber forest products surpassed that of timber (de Beer & McDermott 1997).

One of the product that traders came looking for in Borneo was honey. It is not clear when honey, or the wax derived from it, became important trading commodities. In the first century AD, China already imported honey "from the West" (Crane 1979: 458). Records indicate that products from Borneo were being exported to China at the beginning of the third century AD (Peluso 1983). These exports may have included honey and wax. Other reports mention that local forest product collectors sold beeswax to merchants towards the end of the first millennium (King 1993), and continued to do so in the nineteenth century (Veth 1854). De Mol (1934) reports a decline in the sale of honey and wax from the Danau Sentarum lake district since about 1930, although today this area is one of the most important honey collecting areas in West Kalimantan. Beside its importance as a marketable commodity, honey is cherished by local collectors for its taste and medicinal properties, as well as for its magic-religious attributes (Crane 1979).

3. HONEY TREE MANAGEMENT AMONG *BIDAYUH* APICULTURISTS

In Kalimantan, *A. dorsata* bees make their nests in a number of tree species that are large emergents with wide and open crowns. People in Ngira call these trees *sompuat*, while Danau Sentarum *Iban* call them *lalau* (Rouquette 1994; Dudley and Colfer 1993). The exact species of inhabited trees vary by area. Rouquette (1994) reports that in the Danau Sentarum lake district in West Kalimantan, *A. dorsata* nest in *Gluta renghas, Dipterocarpus gracilis, Dipterocarpus tempehes*, and *Vatica menungau* trees. People in Ngira report that six tree species are inhabited by honey bees. These include several dipterocarps (e.g. *Shorea laevifolia*), but the most important are *Koompassia excelsa* and *K. malaccensis*. *K. excelsa* is the tallest recorded broad-leaf rainforest tree, and the sixth largest tree in the world (PROSEA 1994), and therefore very appropriate for occupation by honey bees who prefer a nesting site that is open and easily to be reached. Both *K. excelsa* and *K. malaccensis* are found throughout the island of Borneo (de Wit 1947). Many forest dwelling people protect them and tend them as honey trees.

Once *Bidayuh* apiculturists find honey trees, they strive to maintain an optimum habitat for bees. A single person or a group may tend a honey tree, thereby acquiring the exclusive right to harvest the honey from bees that nest there. To make a honey tree a more attractive nesting site for the bees, while also making it easier to harvest the honey, the owners of the tree slash the surrounding trees and other vegetation to about 5 m from the stem, and also gird large trees close by. This practice makes honey trees distinguishable as single standing specimens. Yet even the surrounding vegetation is cleared, a honey tree must nonetheless be part of a forest to provide an attractive nesting site for bees. For this reason, *Bidayuh* apiculturists generally maintain areas of forest around tended honey trees. In doing so they commonly modify the surrounding forests so they yield other products for sale or daily use. The forests may be planted with rubber or fruit trees, for example, while continuing to slash or gird other non-desired trees.

Today, honey tree owners find it more difficult to protect the forests around *sompuat* because of an increasing shortage of appropriate swidden land. This situation has forced many *K. excelsa* and *K. malaccensis* honey tree owners to slash the surrounding forest or allow other farmers to do so. Many honey trees belonging to other species are still found in closed forests, but many are also located in landscapes. *A. dorsata* swarms do not visit the trees in the open landscape anymore, and seldom even visit honey trees in closed forest areas, possibly because they find insufficient flowering trees in the vicinity. As a result, honey tree owners have much less opportunity today to collect honey from their trees than when the forest was still abundant. In Ngira 60 families owned a total of 272 *sompuat* trees, or an average of 4.64 per household (See Chapter Four).

When bees do come to inhabit honey trees, their arrival is heralded in advance, according to local folklore. This occurs when large schools of fish known as *ikan tanua* (cf. *Puntius tetrazone*) migrate upstream. Villagers notice when these fish pass the local bathing places. The *ikan tanua* are striped, much like the *A. dorsata* bees. People believe that these fish swim upstream all the way to the source of the river, where they arise from the water, turn into bees, and depart to build their nests in honey trees that have been carefully prepared.

4. HARVESTING A *SOMPUAT*

When a honey tree is ready to be harvested those undertaking the task leave the village about noon. Near the site of the tree they will construct a small hut to provide temporary shelter in the event of rain during the night. Then they begin the arduous work of constructing a stairway up to the trunk of the towering tree. The stairs are made from bamboo stalks that are split and cut into pieces about 50 cm long and two cm wide. These pieces are sharpened so the stalks can be driven into the wood of the honey tree, and are inserted in pairs about 60-70 cm apart. Poles of saplings from other species are used to connect the pairs of bamboo pins. The first pole is firmly rooted on the ground, then tied to the first set of bamboo pins, with a liana, locally called *pese* (cf. *Meliosma nitida* Bl.). This procedure continues until the first pole is finished. A second one is tied to the first one, and additional poles are added, each one time tied to pairs of bamboo sticks. In cases where a bees nest is very large, the honey collectors have to construct a passageway from the branch on which the nest is suspended. They use a small *Diospiros auren* tree for this purpose, from which they cut the branches at about 10cm. This tree it is tied upside down from the branch, often at a height of as much as 30 m.

By the time the honey collectors finish building a stairway to the bees nest, it is usually night time and quite dark because honey trees are harvested only during moonless nights or when the moon comes up very late. When the harvest is ready to begin, one person climbs the tree and uses a torch to smoke the nest until most of the bees have been numbed. This torch is prepared by *Bidayuh* people using a *Mallotus* sp. liana; Danau Sentarum collectors use *Ficus microcarpa*. The torch is made from one-meter-long pieces of either species, which are first crushed, then split and dried over fire, and finally tied loosely together. The collector uses the burning torch to brush the bees from the nest. The harvesting can be dramatic as pieces of burning wood fall to the ground and bees that manage to escape will fly around.

Once the nest has been cleared of most bees, the collector hauls a large tin can underneath the nest. The nest is then slashed so that the honey drains into the can. The rest of the nest is cut and stored in a basket to collect wax as well as larvae, which are a popular snack. A single large nest can yield up to 20 kg of honey, although people have reported harvests of 100 kg from a single tree. More and more frequently, however, there is much less honey being collected, or the numbers of people participating in the harvest is so large that everyone receives only a small share. Once the shares have been divided, everybody is satisfied and people return home, usually well past midnight.

5. BEEKEEPING IN DANAU SENTARUM

Danau Sentarum, North of the Kapuas River in the district of Kapuas Hulu, is an area of interconnected lakes and flooded forests. Malay fisherfolk live by the lakes, while *Iban* Dayak reside in the surrounding hills. Although fishing is the most important activity of the Malay, reports mention their commercial honey collecting since the 1930s (de Mol 1934). The *Iban* Dayak collect honey from *lalau* honey trees, which may have 30 nests and produce over 100 kg of honey in one season (Rouquette 1994). The Malay, however, collect honey mainly from nests located on wooden boards, called *tikung*, which have been purposely set out to attract *A. dorsata* bees.

A honey board is about 1.5m in length and 20cm wide, and has a convex shape. The upper surface is carved so that rain water runs off. At both ends of these boards carvers cut indentures in which branches are inserted; these are used to attach the board to a tree using wooden pegs. Carvers use several timber species to make boards, but prefer *Fragrea fragans*, a common species in the area (Peters 1994). The owner places a honey board in a suitable tree at an angle to prevent water seepage; most commonly the boards are placed in *Syzigium clariflora, Mesua hexapetala, Barringtonia acuangula*, and *Carallia bractiata* trees (Rouquette 1994). Once a swarm has occupied a honey board, bees will usually return there every year, and a board can last up to 20 years. Besides cutting some branches when the board is installed, no other care is needed. Owners generally harvest an average of 5.8 kg of honey five to eight weeks after a bee swarm has occupied a board.

De Mol (1934) reported in the 1930s single households using between 40 and 150 honey boards. Rouquette (1994) and Peters (1994) found some owners having 200 boards. De Mol's estimate that as many as half of 1000 families participating in the honey and wax collecting business is consistent with estimates by Peters (1994) indicating involvement rates of 50%, 60%, and 72% for three villages he surveyed. A single family may collect between 53 and 267 kg of honey per year. In 1994 this could be sold at a price of about US$ 0.75/kg (Peters 1994); hence, Danau Sentarum honey collectors could earn between US$ 40 and US$ 200 per year from their bee-keeping activities. This is substantial additional income in a region where the total annual income for many small farmers is within that same range (Clause 1991, see also Chapter Two). On the other hand, the forest fires that have occurred repeatedly over the last few years in Kalimantan have damaged honey boards, decreasing the number of bees in the area and substantially reducing incomes from honey sales.

6. RULES CONCERNING HONEY TREES

The behavior and relations of Borneo's indigenous Dayak is regulated by a well-developed system of customary law (King 1993). Among *Bidayuh* people, ownership of a honey tree needs to be established only once (e.g. Tsing 1995). Most Dayak groups have special rules concerning honey trees and the right to harvest them. Richards (1964) states in his report on *Bidayuh* customary laws that the penalty for stealing honey from somebody else's honey tree is 4 units of punishment. A single unit of punishment equals one ceramic jar; a certain amount of chicken, pork meat, and rice wine; or an equivalent in money. Penalties are usually imposed as a finite number of punishment units, varying according to the seriousness of the offense. Accidental burning of a *Koompassia* tree has a punishment of 2 units. However, purposely slashing somebody else's *Koompassia* tree has a penalty of one Chinese luxury jar, which is an unusually heavy fine in the *Bidayuh* legal system. Jangkang Dayak from the area east of the Ngira, people penalize slashing somebody else's *Koompassia* tree with a punishment of 6 units. They value one unit as an equivalent of about US$ 40.

One rule held by the *Bidayuh* says that no person except the owner of the honey tree may slash the forest in an area within a radius of about 100m, unless given permission by the owner. This rule ensures that the surrounding forest of a honey tree is maintained and the habitat for bees is preserved. Among most Dayak, natural forest may be occupied by anybody who is member of the community that holds rights over a village territory. Farmers, however, can obtain exclusive access to natural forests in several ways. They may slash the underbrush of the forest vegetation, indicating their claim to use that particular tract for swidden making. In addition, farmers have the exclusive right to make a swidden in the forest next to their agricultural fields, and in the direction in which these are advancing (Dove 1985). In both situations, however, farmers can reserve only relatively small areas of forest. A farmer may, however, own several honey trees that are located at distances of about 300 m or less from each other. In such cases it is impossible for anybody else to make a new swidden in the forest between those trees without violating the rule that the neighboring forest of honey trees should be left intact. As a consequence, the farmer gains the exclusive right to make new swiddens in this part of the forest. When still sufficient forest was available, some farmers used this rule to reserve large tracts of forests for future swidden making.

Unlike Dayak apiculturists, who have a single hierarchy of authorities responsible for implementing all traditional laws, in Danau Sentarum villages a special person is in charge of implementing rules concerning honey exploitation (Rouquette 1994). Putting up new boards requires permission from this person, and in some villages a new beekeeper must have a minimum number of boards before harvesting can be done. Although the *Iban* in Danau Sentarum hold exclusive property over *lalau* honey trees, the Malay do not recognize such formal ownership over the trees where *tikung* are placed. However, the right to use these trees is exclusive, with nobody else allowed to put boards in a tree that has already been occupied. In some villages this practice is not allowed even within a distance of 25m from an occupied tree. Since occupation is, in fact, permanent, having one's honey board in a tree in practice gives the same rights over that tree as formal ownership does. Penalties for damage and theft of honey boards range from an equivalent of US$ 1 to US$ 50 (Rouquette 1994).

7. FOREST PRESERVATION AND RESTORATION THROUGH APICULTURE

In many areas where organizations seek to address conflicts between over-exploitation of resources, economic development, and biodiversity conservation, commercialisation of forest products is often proposed as a strategy to increase income. This is often an important, although not the only, prerequisite to finding a balance between enabling people to make a sufficient livelihood and preserving nature. Regional development organizations have worked to increase income from honey among the inhabitants of the Danau Sentarum area (Wickham 1997). The expectation is that once this has been achieved, the Malay population may agree to reduce its fishing activities, thereby decreasing pressure on fish populations. In addition, it is hoped, they will reduce the related burning of vegetation adjacent to fishing grounds (Rouqette 1994). The local inhabitants have harvested honey for many years, apparently without negatively affecting the bee populations. Thus, increasing income from honey appears to be an attractive strategy to meet the dual goals.

Exploitation of honey as a means to increase monetary income, is not a viable option now in villages like Ngira, Teriang and Koli because yields are low as a result of infrequent visits by *A. dorsata* bees. However, most of the district of Noyan, where people from Ngira and Koli live has become the target of an Indonesian-German Social Forestry Development Project (de Jong and Utama 1998). Among other activities, this project aims to reforest *Imperata cylindrica* or other fallow lands. Management of *sompuat* honey trees, and the customary laws that rule ownership and protection of this natural resource, provide an excellent opportunity for reforestation that is adapted to local resource control. If *sompuat* honey trees are used as focal points around which to centre reforestation efforts, reforested land will become subject to mechanisms that control their burning. Farmers in Ngira and Koli have reported how they traditionally located fields, fallows, and rubber gardens so that burning of honey trees could be avoided, to escape the heavy penalties.

These two examples of local resource use and the complex socio-cultural customs and rules systems surrounding them demonstrate how important it is not only to assess the socioeconomic and ecological aspects of local resource management practice, but also to thoroughly understand the cultural context of resource utilization. Only such understanding will lead to new resource use options that incorporate local social and cultural norms. The two cases discussed here suggest that such options may be very site specific.

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