18 Secondary Forests in West Africa: a Challenge and Opportunity for Management

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Abstract: Secondary forests cover about 90% of West Africa's forests. These forests are often degraded and are under strong and diverse pressures. Concepts on how to deal with this type of land resource are mostly missing. It is thus necessary to develop options for a wise and sustainable utilisation of secondary forests. Prerequisites for the development of rehabilitation concepts are knowledge and understanding of the ecological processes within the ecosystem, especially succession. Based on this knowledge, silvicultural management options can be designed, or complementary land-use systems may be identified and applied. Silvicultural systems offer a variety of opportunities, such as enrichment planting, refining, and liberation to gradually re-convert degraded forests into valuable timber resources. Agroforestry offers various possibilities for close-to-nature management and economic improvement of impoverished resources. New approaches, like outgrower schemes, can play a catalyst role for a broader implementation of agroforestry. Simultaneously, this land-use system contributes to food security, thus stabilising the livelihoods of rural populations. Furthermore, non-wood forest products bear a substantial potential for the valorisation of secondary forests that, ideally, will result in sustainable utilisation of the resource.

Keywords: secondary forests, diversity, forest management, agroforestry, NWFP, outgrower system, West Africa

18.1 Introduction

Forests in West Africa are under serious threat. The Food and Agricultural Organization of the United Nations (FAO 2006) estimates the annual rate of deforestation in the region at 4.2 million ha, or 0.64% per year, although this average figure conceals the dramatic situation in some countries: In the period from 2000 to 2005, FAO observed a net loss of forests of 4.5% in Togo, 3.3% in Nigeria and 2.0% in Ghana. Together in these three countries, forest destruction amounted to 745 000 ha per year. The combined effects of over-exploitation of forest resources, unsustainable land-use practices (e.g., slash and burn or cocoa farming), wild fires, mining activities, and political unrest (e.g., Liberia and Sierra Leone) have significantly reduced the forest area.

Continuing forest destruction results in habitat loss for faunistic and floristic elements, thus reducing biodiversity, accelerated soil erosion with degraded agricultural productivity and, consequently, deterioration of the livelihoods of rural people. If the forests are not completely cleared and transformed into other forms of land-use, degraded or devastated vegetation cover remains. Ideally, under undisturbed conditions and over the course of long time spans, succession gradually restores forest-dominated ecosystems to something resembling the original composition.

Today, high pressure on natural resources from anthropogenic disturbances affects, and often interrupts, the succession process, with the consequence that the extent of secondary forests is rapidly increasing in the forest zone of West Africa. For instance, according to FAO (2006), in 2005, the proportion of secondary forests of the total forest cover in Guinea, Liberia, and Benin was 98%, 96%, and 95%, respectively. Also, all other countries in the region reported a secondary forest cover of 90% or more.

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Photo 18.1 Heavily degraded secondary forest in the semi-dry zone of Ghana with *Vitellaria paradoxa*, *Bridelia ferruginea*, and *Daniellia oliveri* as main tree species. *V. paradoxa* fruits are the source of shea butter.

The occurrence and composition of secondary forests – as well as primary forests – in West Africa varies greatly mainly due to the differences in rainfall regimes. Moist forests are predominantly found close to the Atlantic Ocean, where sea winds provide high rates of precipitation. Further toward the interior, rainfall rates decrease, leading to drier forest types like deciduous, semi-dry, or dry forests. The dry forest ecosystems, which are particularly susceptible to disturbances, have been subjected to many forms of degradation in the past. At the same time, dryland ecosystems are also resilient, which improves their capacity to absorb change and disturbance.

Although there is no unanimously accepted definition of secondary forests, the following comprehensive definition is applied: Secondary forests are forests regenerating largely through natural processes after significant human and/or natural disturbance of the original forest vegetation at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition, with respect to nearby primary forest on similar sites (Chokkalingam and de Jong 2001). Natural causes for major forest disturbances can be fire, storms, and insect infestations, among others; whereas human-induced disturbances are mainly shifting cultivation with the use of fire and timber logging.

This chapter will first discuss the importance and threats to secondary forests in West Africa, followed by a description of the floristic diversity and forest succession in secondary forest ecosystems. Section 18.6 focuses on silvicultural and complementary management systems and the opportunities and challenges related to them. Conclusions and recommendations are presented in the last section.

18.2 The Importance of and Threats to Secondary Forests in West Africa

In 2005, the FAO assessed the forest cover in West Africa at 57.9 million hectares, or 31% of the land cover (FAO 2006). The population in the area amounted to more than 220 million people, of which up to 74% are rural. It can be assumed that at least 110 million people in West Africa live adjacent to, or even in, forests. Given that 90% of all forests in the region are secondary forests, a population of approximately 100 million may live in and gain sustenance from

Box 18.1 Geographical determination of West Africa

The definition of the term "West Africa" is not homogeneous. According to the United Nations, West Africa, geopolitically, is the westernmost region of the African continent and includes 16 states with an area of slightly more than 6 million km². To the north, it borders North Africa; to the southeast, it borders Central Africa. Like a belt, West Africa stretches from Mauritania in the northwest to Nigeria in the southeast.

The FAO excludes the Sahelian countries Burkina Faso, Mali, Mauretania, and Niger from West Africa in the Global Forest Resources Assessment, and adds these countries to North Africa (FAO 2006). In this section, the term West Africa is used in accordance with the UN definition.

The vast majority of the land is plains, at an average elevation of 300 m a.s.l. The semi-arid Sahel forms a transition zone between the Sahara in the north and the grass-dominated savannahs further south. Closer to the Atlantic Ocean, where there is more precipitation and a higher amount of humidity, various types of floristically rich and diverse tropical moist forests occur. Forestry and timber play a major role only in the economies of the countries with moist and semi-moist forests; whereas the dry interior of West Africa is characterised by a notorious deficiency of wood and wood products.

this environment.

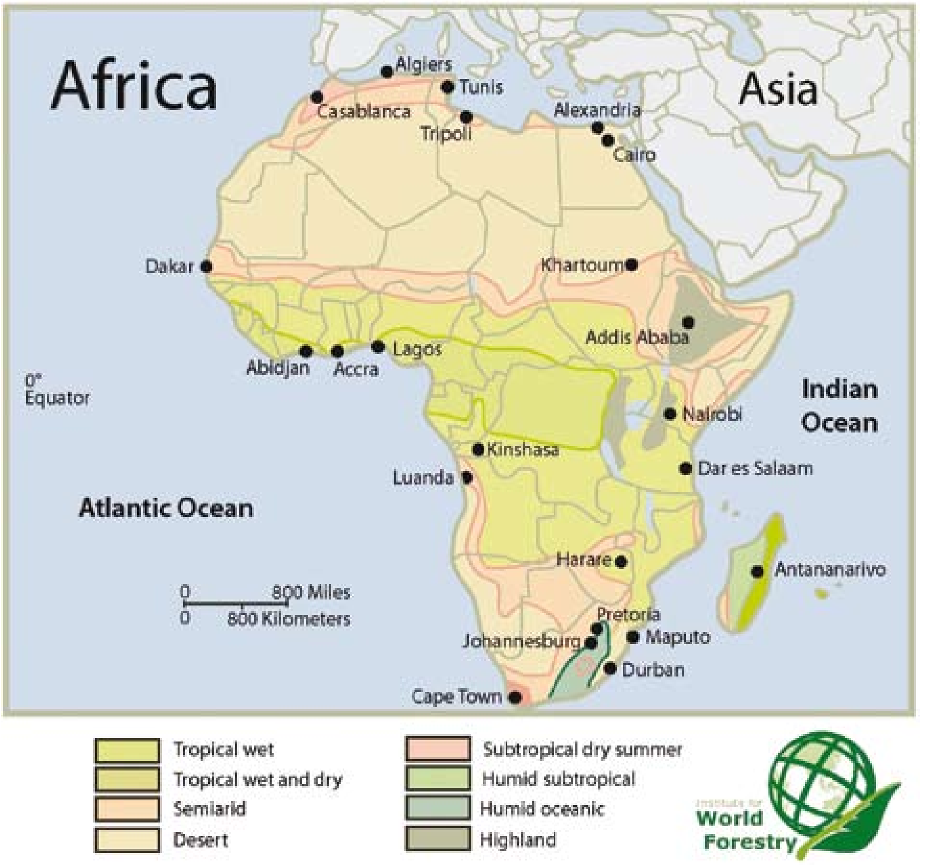
Secondary forests can provide a huge variety of tangible products, such as timber, fuelwood, and non-wood forest products (NWFPs), and intangible environmental services, such as erosion control, halt of desertification, atmospheric carbon sequestration, refugia for biodiversity, or conservation of the water balance. Beyond this, forests also have traditional, religious, and spiritual functions for forest dwellers. However, secondary forests are of highest importance for the local population as an easily accessible land reservoir for slash-and-burn agriculture. This archaic agricultural system comprises the clearing of forested sites through the use of fire and the subsequent cultivation of agricultural products. The practice mainly provides for subsistence use and is characterised by short production cycles and huge land consumption because the soil productivity decreases quickly. When the productivity of the land has reached such a low level that further cultivation does not reward with sufficient crop yield, the farmer will abandon the land and natural succession processes will start on the site.

On one hand, fire as the tool for land clearing is an advantageous means for mobilizing nutrients. On the other hand, fire affects the ecosystem drastically with numerous negative effects. Fire is a permanent hazard for the environment, especially when it runs out of control and causes tremendous destruction to the landscape. Such an incident occurred in 1983, when millions of hectares of forest were burning in the savannah transition zone of Côte d'Ivoire, Ghana, and Togo. Many cocoa plantations and natural forests in the area were destroyed, which resulted in an almost complete breakdown of the cocoa market and industry. The forest was widely replaced by dense grasses that invaded from the savannah zone and suppressed the natural regeneration of the forest (Abebrese 2003).

Many bushfires are also set deliberately, especially during the dry season, to improve the grazing conditions for cattle, to control insects and pests, to drive out game for hunting, or simply to reduce combustible litter. In 1973/74, and from 1982 to 1984, Ghana experienced serious bushfires with more than 1000 cases of fire during each of these periods. During these years, the bushfires correlated with extreme weather conditions: the catastrophic Sahelian drought in 1973/74, and, in the 1980s, the severe harmattan season. During one year, 35% of crops were destroyed in Ghana, causing a dramatic situation for the rural population (Abebrese 2003). Prescribed burning early in the dry season, when there is still some humidity in the grass cover, tends to reduce the negative impacts of fire.

In many countries of the region, secondary forests are not sustainably managed or developed. To overcome this requires understanding the particularities and the functioning of secondary forest ecosystems, and the demands and expectations of the people in relation to this environment. Adequate attention to these factors forms the basis for the development of sustainable land-use options.

In order to formulate appropriate secondary forest management strategies, it is imperative to understand the process of secondary forest succession, the floristic composition and diversity of secondary forests, the disturbance regime, and site history.



Map 18.1 Main climate zones of Africa (developed by Institute for World Forestry, Johann Heinrich von Thünen-Institut, Hamburg, Germany 2010).

18.3 Floristic Diversity of Secondary Forests in West Africa

Secondary forests in West Africa consist of a vast variety of forest types distributed mainly according to the different rainfall regimes. Moist forest types obtain a different floristic and structural diversity than drier forest types. This is essential when management options for secondary forests are addressed. It is therefore necessary to highlight the main ecological differences between the two forest types.

18.3.1 Floristic Diversity of Moist Secondary Forests in West Africa

The West African moist forests are rich ecosystems with complex structures, but they cover a smaller area and contain fewer numbers of species than the Central African moist forests. Nevertheless, West African moist forests are still diverse and contain many notable endemic species (Sayer et al. 1992). Côte d'Ivoire, Ghana, and Nigeria are among the 50 most biodiverse countries in the world (WCMC 1994).

The moist forest type extends along the coast of West Africa from Senegal in the West to Togo in the East. The Dahomey Gap in Benin separates the West African moist forests floristically from the Central African forests (Sayer et al. 1992). The West African closed forests are not homogenous and can be divided into seven major forest types: wet evergreen, moist evergreen, moist semi-deciduous, upland evergreen, dry semi-deciduous, southern marginal type, and southeast outliers (Richards 1996).

Generally after disturbance, the regeneration and secondary succession of tropical moist forests is rapid in terms of species richness, plant growth, and other developmental features (Murphy and Lugo 1986, Vieira and Scariot 2006). However, the whole process of moist tropical forest recovery, particularly in terms of species composition, may probably extend over centuries rather than decades (Richards 1996).

Usually the succession starts with herbaceous species, which rapidly form closed ground cover for brief period before being shaded out by woody species (Richards 1996, Abebrese 2003). Young secondary forests (15–20 years) in the moist West African forests have similar structural and vegetational succession patterns, with dominance of one to four early pioneer species, such as *Macaranga* spp., *Musanga* spp., or *Cecropia* spp. The late secondary forest species (30–40 years) that can form the dominant canopy layer include late pioneer species, such as *Terminalia* spp. and *Ceiba pentandra* (ITTO 2002, Richards 1996).

Alien invasive plant species tend to be found abundantly in clearings and young secondary forests. In West Africa, the alien tree species *Cecropia palmata* and the herbaceous species *Chromolaena* spp. are widely distributed in young secondary forests.

High abundance of climbers is one of the distinguishing characteristics of young secondary forests. The common climbers in West African secondary rainforests include *Adenia lobata*, *Dioscorea preussii*, *Diocoreophyllum comminsii*, *Gouania longipetala*, *Montandra guineensis*, and *Parquetina nigrescens* (Muoghalu and Okeesan 2005).

18.3.2 Floristic Diversity of Dry Secondary Forests and Savannahs in West Africa

The dry forests, woodlands, and savannahs of West Africa are located north of the moist closed forest zone. They consist of trees of smaller stature, which have discontinuous canopy, and a grass ground cover. The savannah and dry woodland is the most extensive biome in West Africa and extends approximately from 7°N to 14°N (Baker 2000). The West African savannahs and dry forests have a lower species richness compared to the moist forests in the region and other areas in Africa (Menaut et al. 1995). The dryland vegetation of West Africa is divided into three main zones: the Guinea, Sudan, and Sahel zones (Lawson 1986). Species diversity decreases northwards (from Guinea to the Sahelian zone), a feature that corresponds with declining rainfall, tree height, and structural complexity (Menaut et al. 1995). In general, the dry forests of West Africa show a strong trend in declining diversity with increasing dryness, which implies that the driest forests have large populations of relatively few tree species (Swaine 1992).

Due to the suitability of the dry forest and savannah zone of West Africa for agricultural activity and human settlement, there has been widespread clearance of the dry land vegetation, especially by using fire (Sanford and Isichei 1986, Maass 1995). The occurrence of disturbances and particularly fire in woodlands and dry forests of West Africa, converts dry forests (through regressive succession) into increasingly open types of forests and subsequently to savannah-like ecosystems (Vieira and Scariot 2006). The main effect of fire in this biome is to maintain a higher ratio of grass to woody vegetation than would otherwise exist (Menaut et al. 1995). Moreover, fires in the dry forests and savannahs of West Africa promote the germination and dominance of fire-tolerant woody species, such as the Acacias, and reduce the abundance of fire-sensitive species.

After disturbance, vegetative regeneration from root suckers and coppice shoots is the primary regeneration mechanism in dry forests of Africa (Murphy and Lugo 1986, Menaut et al. 1995). If frequent fires and grazing are curtailed from savannahs, a dense undergrowth of herbs, shrubs, and young trees derived from both vegetative sprouts and seeds will be established at the initial phase of a secondary vegetation succession (Swaine 1992). In the later stages of succession, the herbaceous species are gradually replaced by woody species to form dense woody stands with a sparse grass ground cover on sites with suitable soil conditions (Sanford and Isichei 1986, Menaut et al. 1995).

Similarly, the abandonment of cultivated lands under the shifting cultivation process will also lead to secondary vegetation succession. For instance, in the dry forest zone of Benin, this has led to the establishment of *Ceiba pentandra* and *Ficus capensis*, followed by an increase in tree density and the formation of dense forest containing such species as *Gardenia triacantha*, *Pancovia bijuga*, *Cassipourea congoensis*, and *Pouchetia africana* (Nansen et al. 2001). However, in terms of plant growth and other developmental features, succession is generally a slower process in dry tropical environments than in moist areas. On the other hand, dry tropical forests – which are less complex floristically and structurally, and which show a lower number of successional stages – have the potential to recover to a mature state faster than moist forests, especially in terms of species composition. These properties of dry tropical forests are considered to make them more resilient (Murphy and Lugo 1986, Kennard 2002).

18.4 Secondary Forest Succession and Floristic Diversity

In general, secondary forest succession can be understood as a continuum. In the early stage, the factors that govern colonisation are most important. In the later stages, competitive ability and tolerance of environmental conditions among species largely dictate patterns of species replacement over time (Walker and Chapin 1987, Guariguata and Ostertag 2001).

The general pattern observed in tropical dry and moist forest succession is that initial colonisation is dominated by herbs, ferns, shrubs, and climbers, all of which are quickly established after disturbance. These species are succeeded by the emerging relatively short-lived, light-demanding, and fast-growing early pioneer species that then dominate the canopy of secondary forests. These early pioneer species are in turn survived by long-lived pioneer species that dominate the canopy until senescence or disturbance cause their death (Guariguata and Ostertag 2001, Breugel 2007). If no further disturbances occur, the canopies of the secondary forests may be gradually replaced by more shade-tolerant species, which leads to the floristic composition of the stand resembling that of an old-growth forest. However, as the dominance of some long-lived pioneer species can persist for decades, or even centuries, secondary forests, even when fairly old, may differ in floristic composition from primary forests (Breugel 2007). In general, many forest functions and characteristics (biomass, basal area, stem density, species density, etc.) may resemble old-growth conditions long before species composition does (Guariguata and Ostertag 2001).

In comparison to the canopy species, the understorey species density tends to be much higher and species composition approaches that of old-growth forest more rapidly (Lawrence 2004). This indicates the persistence of long-lived pioneer species in the upperstorey, and a continuous recruitment with relatively faster species replacement of shade-tolerant species in the understorey (Breugel 2007).

The species richness of shrubs and lianas tends to decrease in late successional stages of secondary forests (Quesada et al. 2009). The limitations in light availability and lack of suitable structural support for lianas at the late successional stages – the height of trees in late successional forests is beyond the optimum height growth range of lianas – are the reasons stated for the decline in the abundance of lianas (Madeira et al. 2009).

A range of factors determine the pace at which secondary forest succession proceeds. These factors include the type, intensity, and duration of the perturbation; the distance to old-growth forest; and the availability of seed-dispersers. Furthermore, site conditions, such as, microclimate and edaphic factors, as well as the soil seed bank and the potential for root and stump resprouting, influence the successional processes (Breugel 2007, ITTO 2002). Hence, due to the multitude of factors that influence successional processes, it is difficult to predict the species replacement patterns at a given site.

18.4.1 Successional Limitations

The dispersal of large-seeded late-successional species, especially those dispersed by vertebrates, may be limited. Therefore, these species are expected to have a lower rate or likelihood of colonising degraded sites. Moreover, behavioural studies indicate that seed-dispersing animals often prefer smaller, rather than large, seeds for long-distance dispersal. Hence, the limited dispersal of large-seeded relative to small-seeded plant species suggests that many secondary forests may be overwhelmingly composed of small-seeded pioneer plant species (Wunderle 1997). Lack of seed dispersal of large-seeded, usually late-successional species, may slow down the overall successional process.

Secondary forest succession may be retarded or inhibited by thickets of bamboo, which form bamboo-dominated, or even monospecific, stands. The presence of bamboo may arrest forest succession by root competition and mechanical crushing (Griscom and Ashton 2003). In addition, as is the case in West Africa, degraded sites invaded by grasses, such as *Imperata cylindrica*, and ferns, such as *Pteridium aquilinum*, also arrest secondary forest succession by competing for resources and because of dispersal limitation; i.e. grasses and ferns are not attractive for seed-dispersing animals and, as a result, there is very limited seed arrival into areas that are invaded by grasses and ferns (Richards 1996, Slocum et al. 2004). Furthermore, grasses increase flammability and result in periodic fires that kill seedlings and saplings of woody species (Duncan and Chapman 2002).

18.5 Conservation and Sustainable Utilisation of Secondary Forests

18.5.1 Biodiversity Conservation

Secondary forests contribute to biodiversity conservation by relieving pressure on primary forests, by functioning as corridors for the migration of flora and fauna in fragmented landscapes, and by maintaining plant and animal genetic resources (FAO 2006). Moreover, secondary forests may function as buffer zones, serve as habitat for forest plants and animals displaced from destroyed primary forests, and as a source of propagules for re-colonisation of degraded forest lands (Brearley et al. 2004). In general, a strategy that combines secondary forest conservation with restoration will attain a better result in the in situ conservation of biodiversity.

As the area of secondary forests in West Africa is expanding and represents the major forest type, the conservation of only old-growth forests in national parks and other protected areas will hardly be sufficient. Also the conservation of secondary forests, which potentially contain a significant proportion of biodiversity, appears to be timely and imperative. A paradigm shift in biodiversity conservation strategies for tropical African forests may therefore be necessary. Furthermore, the conservation of secondary forests will help the West African nations to meet the national biodiversity conservation targets and fulfil international commitments, such as those stipulated by the Convention on Biological Diversity.

18.5.2 Sustainable Utilisation of Secondary Forests

As secondary forests are the predominant forest type in West Africa and many other tropical regions, they provide the productive (in terms of both wood and NWFPs) and environmental functions of primary, old-growth forests (ITTO 2002). If properly managed, secondary forests can generate a wide variety of goods and services to society, especially to local communities that depend on them. Moreover, the relative proximity to human settlements and accessibility of secondary forests have made them readily available as a source for important wood products. Some of the economically important timber species of secondary forests in West Africa include such tree species as *Triplochiton scleroxylon*, *Ceiba pentandra*, *Milicia excelsa*, *Terminalia ivorensis*, *Terminalia superba*, *Lophira alata*, *Alstonia boonei*, *Daniellia ogea*, and *Nauclea diderrichii* (Blay 2002).

In order to sustainably utilise the vast resources from secondary forests in West Africa, appropriate management options that take into account the peculiarities of these forests and the needs of people who depend on these resources for their livelihood need to be identified and implemented. To begin with, management strategies should be based on a sound analysis of the general social, economic, institutional, and ecological context. Hence, the particular ecological and socioeconomic criteria and indicators adopted should be linked to site-specific objectives and goals (ITTO 2002). Moreover, management of secondary forests should be considered in the context of a landscape level approach and multifunctionality. In general, since the development of tropical secondary forest succession is difficult to predict, it is judicious to use an adaptive management approach.

18.6 Management Concepts for Secondary Forests in West Africa

Development goals of secondary forests can be manifold. The objectives can include the attainment of primary forest characteristics, or utilisation as a resource for wood, NWFPs, or environmental services. It is essential to develop specific management objectives for secondary forests either for the application of pure silvicultural activities, integrated land-use systems like agroforestry, or for the introduction and exploration of NWFPs.

Ambitious, broad-scale policy approaches like the Millennium Development Goals or national forest policies have not kept pace with the development in the whole of West Africa. Therefore, it appears to be necessary to improve the living conditions of the people in the countryside by the enhancement of the natural resources. New practical approaches and a return to well-proven sustainable traditional land-use systems are considered to be promising in order to stop the accelerated forest degradation and deforestation in the region. These approaches can be divided into silvicultural and complementary management approaches.

18.6.1 Silvicultural Management of Secondary Forests

Despite their large extent and existing and potential benefits, secondary forests are mostly overlooked in terms of management and development; instead attention is focused on the rapidly diminishing primary forests. In most African countries, secondary forest management has not been given adequate attention, with the result that they are not part of current forest management systems (Blay 2002, FAO 2003). The expanding area of secondary forests and their increasing importance (Finegan 1992) call for systematic management. If properly managed, they can provide important social and environmental benefits, contribute to poverty alleviation, and reduce the pressure on the few remaining areas of primary forest.

Systematic management of secondary forest is relatively new in Africa, primarily because most of this forest type has developed during the last few decades. Effective management of secondary forest can be achieved by (i) involving local communities in implementing management practices, (ii) reducing destructive forest agents (e.g., fire, grazing, farming, and timber harvesting) or administering them in a manner that is ecologically friendly, and (iii) taking into account such factors as age and composition, site history and condition, and multiple-use and management objectives for the forest (ITTO 2002, Nyondo 2002). Secondary forests possess some ecological characteristics that favour their management, among which are: (i) existence of natural regeneration, (ii) relatively uniform species composition, (iii) greater homogeneity in age and size, and (iv) rapid initial tree growth (ITTO 2002).

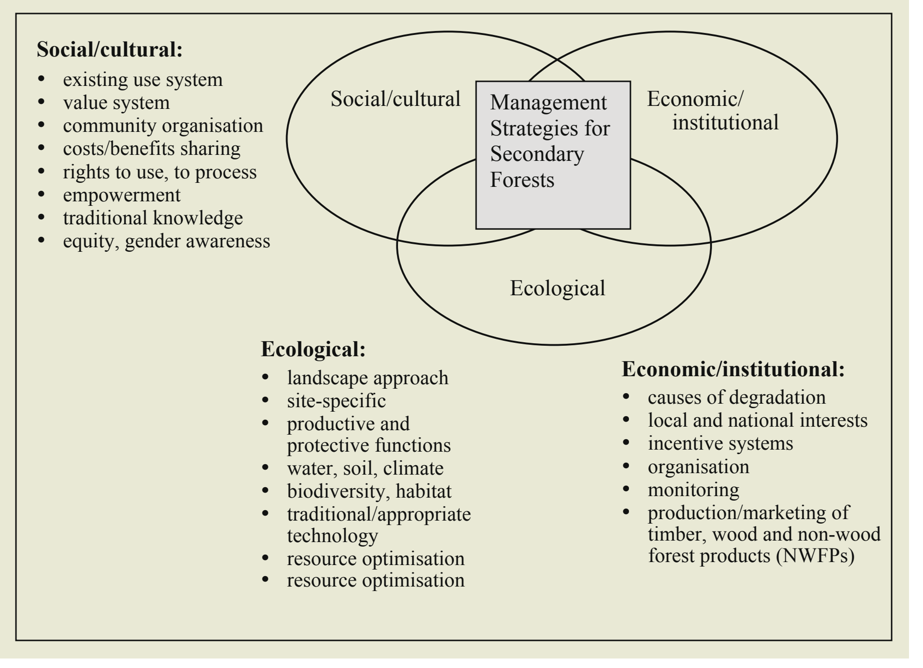


Figure 18.1 Context for determining management strategies for secondary forests (Source: ITTO 2002).

Objectives of Secondary Forest Management

Secondary forest management aims at increasing the forest's capacity to yield products, as well as provide important environmental and social services for a wide range of beneficiaries on a sustainable basis. Generally, secondary forests may be managed for conservation, timber production, and/or multiple purposes. Consequently, their management objectives may be diverse and may vary from one ecological zone to another. The objectives may also compete or may be mutually exclusive. For example, loggers tend to destroy farmers' crops during harvesting and extraction of logs from the forest where farms have been established, while farmers tend to burn all timber trees and their seedlings on their land during site preparation to prevent loggers from logging the forest. Thus, there is the need to involve all stakeholders in the planning of management strategies for secondary forests. However, the specific objectives of secondary forest management will depend on the needs, interests, and capacities (land, labour, capital, skills) of the forest owner, the resource (e.g., existence, density, and size of economically valuable species), and external factors (such as markets for forest products and services, policies, and regulations).

Secondary Forest Management Strategies

Managed secondary forests are often able to provide diverse products and services of social and economic importance. However, the high variability by age, floristic composition, and geographical distribution of secondary forests influences this potential and makes it difficult to define general principles for management. Secondary forest management strategies are planned processes that aim at the enhancement of their functionality. They should be based on a sound analysis of the general social, economic, institutional, and ecological context (Figure 18.1). The management strategy will vary from location to location, depending on the resources available, biophysical characteristics, markets, and opportunity costs.

Fundamentally, management of secondary forests should not differ in its general objectives from that of primary forests, but the specifics will vary. The management strategy adopted must consider species composition, the structure of the forest, and the primary objectives of residents. Specifically, information on the extent, location, condition, conversion processes, as well as current and potential uses of secondary forest is necessary. Silviculture in secondary forests should be based in the first instance on existing natural regeneration (ITTO 2002) because new germination or planting of seedlings is more difficult compared to tending the seedlings already present. Thus, one of the most important tasks in the initial stage of secondary forest management is the

Table 18.1 The four basic silvicultural questions for determining the management strategy for secondary forests.

What are the present stand and site conditions?	◆ Stand: species composition, structure, health, age, regeneration capacity, etc. ◆ Site conditions: edaphic, hydrologic, etc. ◆ Socio-economic context: Who uses the forest, what for, what kind of impact?
What are the stand and site histories?	◆ Determine the cause(s) of degradation: e.g. was the area under shifting cultivation? If yes, what intensity? Is the stand a logged-over forest? Did forest fire occur?
How would the site develop in the absence of planned management interventions?	◆ What will happen to the stand if there is no management? For example, ecologically (succession etc.) and socially (conversion into other land-use etc.)
What management strategies are needed to achieve a particular outcome (restoration, secondary forest management, rehabilitation)? Depending on who manages the forest, the question of who plans, who harvests and who monitors will influence how this will be done.	◆ Participatory and adaptive management planning for the particular forest stand or the degraded site: silvicultural options, collaborative use management, multiple-use management – define objective – specify methods – specify monitoring of forest development, and adopt, if necessary, the strategy and the course of action.

Source: ITTO 2002.

assessment of existing natural regeneration. Since many important timber species are rarely found in secondary forests, the economic value of secondary forests can be increased through management strategies that facilitate the growth of economic tree species (Piotto 2007). The basic questions for determining the management strategy for secondary forests are presented in Table 18.1.

The management strategy ultimately selected will depend on the priorities and objectives of the forest owner, the costs and benefits associated with the strategy, and the economic, social, and environmental values of these land resources in their current and desired future states.

Post-Abandonment Secondary Forest

Traditionally, secondary forests are usually left to restore themselves without any deliberate human intervention, thus they can be managed without specific human restoration or rehabilitation measures. This is attributed to the ability of secondary forests to recover and eventually return to their original "species rich" situation, even after significant degradation. Where a secondary forest is allowed to recover without any significant human intervention, it is referred to as post-abandonment secondary forest, which is defined as forests regenerating largely through natural processes after total abandonment of alternative land-use on formerly forested lands (Chokkalingam et al. 2000). This secondary forest management method has been practised in developing countries, where systematic management of natural forest is not common. In Oluwa forest reserve in Nigeria, the standing timber volume of a secondary forest abandoned for about three decades was almost comparable with that of an adjacent primary forest (Onyekwelu et al. 2008). But the ecological status in terms of trees species composition and dynamics of the secondary forest was by far not similar to primary forest conditions.

The success of simple abandonment as a management strategy for secondary forests will require that all forms of degradation activities (e.g., timber exploitation, fuelwood and NWFP collection, fire, encroachment by farmers) are ceased or reduced to the barest minimum. If this is not done, the forest may not be able to recover. The management challenge in post-abandonment secondary forests is to maintain a certain species composition and structure in the long term and to guarantee the regeneration of the desired species.

Refining and Liberation Thinning

Refining and liberation thinning as principal silvicultural methods are costly and may be regarded as yielding distant future returns. They reduce the time in which a merchantable crop of timber and NWFPs will become available. Refining refers to the elimination of undesirable trees, climbers, shrubs, and other plants that will inhibit site occupation by desirable trees. Liberation thinning refers to the cutting that relieves young seedlings, saplings, and trees in the sub-canopy layer from overhead competition (ITTO 2002). Refining tends to allocate growing space to a group of species (the potential final-crop trees) at the expense of others. To some extent, refining can jeopardise species diversity and may endanger the ecological integrity of a stand, thus care must be taken to avoid a too big loss of species diversity (Grieser 1997). In the past, this method was used to eliminate tree species that were thought to be "useless." Thus, the method is constrained by the limited knowledge of the usefulness of many tree species in tropical forests and the continuing utilisation of species that were once considered "useless." A reasonable compromise to minimise tree elimination is to leave sub-canopy species and tree regeneration layers of the canopy as intact as possible, while removing only those trees and climbers that overtop the desired trees (ITTO 2002). Liberation thinning stimulates growth, since tree growth is directly related to the formation of a healthy and dense crown.

Enrichment Planting

Enrichment planting is perhaps the most popular and appropriate management strategy for secondary forests (Piotto 2007). It is employed to increase the stocking of valuable tree species in degraded or secondary forests, where regeneration of the required species is scanty, partially successful or completely absent, without removing the trees already present (Nwoboshi 1982, Lamprecht 1990, Montagnini and Jordan 2005, Piotto 2007). The method is commonly used to increase the quality and quantity of wood in secondary forests. The experience with enrichment plantings in secondary forests has generally been more favourable than in primary/logged-over forests. Young secondary forests are more receptive to silvicultural manipulations because of their manageable tree size and rapid growth response. Enrichment planting requires canopy manipulation in order to optimise the growth and survival of planted trees. The use of enrichment planting will require adequate information on species diversity, level of stocking, growing stock, and the species that will meet the management objective. Generally, the tree species that dominate secondary forests are apparently unable to regenerate under their own shade, as suggested by the absence of small size classes in stem-diameter distributions, changes in tree species composition across a forest chronosequence, and by monitoring tree recruitment over long periods (Knight 1975, Lang and Knight 1983, Saldarriaga et al. 1988, all cited by Guariguata 2000).

Due to the relative management complexity of enrichment planting, basic information about the species ecology is fundamental in order to select potential species and predict their response to management activities. Since trees are planted under shade, the selected species must be shade-tolerant to a certain degree. Therefore, pioneer and late-successional species that are light demanding are used to a very limited extent for enrichment plantings. Important silvicultural characteristics for species that are ideal for enrichment planting can include: high value timber, low crown diameter, regular flowering and fruiting, wide ecological range, fast growth rate, tolerance to moisture stress, good natural stem form, pests and diseases tolerance, drought resistance, or ability to grow in low-nutrient soils (ITTO 2002). All these characteristics depend mainly on the production goal and site conditions. In Uganda, for example, tree species that produce food are combined with timber species in enrichment planting to improve the socio-economic value of the forest (Grieser 1997). Enrichment plantings with *Nauclea diderrichii* (a strong light demander) in Nigeria failed due to insufficient light for the saplings, whereas *Khaya ivorensis* (a shade-tolerant species) planted under similar condition recorded 83% survival (Nwoboshi 1982).

Success or failures in enrichment planting depend largely on species selection and the level of adherence to sound planting and tending practices. Necessary conditions for successful enrichment planting include the provision of adequate light conditions, proper supervision, and follow-up maintenance. The poor reputation and failures associated with enrichment planting are largely attributable to the improper selection of planting stock, insufficient overstorey opening prior to planting, insufficient follow-up tending, and pest attack (ITTO 2002). The experience from Nigeria has demonstrated that results from enrichment planting may vary with the type of planting stock used (Table 18.2).

Table 18.2 Differential performance of planting stock in enrichment planting.

Species (and age)	MAI (ht) (cm)		Survival (%)	
	striplings	stumps	striplings	stumps
Entandrophragma angolense (5 years old)	16.9	28.9	61	29
Khaya ivorensis (5 years old)	23.1	40.6	27	19
Lovoa trichilioides (4 years old)	43.5	47.3	75	53

Source: Nwoboshi 1982.

Challenges of Secondary Forest Management

There are quite a number of challenges associated with secondary forest management, among which are:

a) Although the extent of secondary forests in West Africa is fairly well-known (FAO 2006), the degradation status and importance of secondary forests in Africa has hardly been systematically explored and documented. Thus, secondary forests are largely invisible in current forest statistics, policy and planning, as well as in forest research in Africa.
b) The dominance of seed banks and seed rains by herbaceous, shrub, and climber seeds is a common phenomenon in secondary forest stands, resulting in a need for weeding, thus making interventions more labour-intensive and costly.
c) So far, management of secondary forests has not been given significant attention in most West African countries. Two main reasons for this may be that (i) there is no universal definition of secondary forests in the region, and (ii) governments may not consider forestry statistics as being an important issue and therefore may not allocate funds for the activity.
d) Despite their importance, secondary forests in Africa are often eliminated as quickly as they become established to make room for other land-uses. If secondary forests are to be conserved and managed productively, the farmers or communities that manage them must receive benefits that justify that management. The benefits provided by secondary forests should be greater than that of alternative land-uses.
e) There is a lack of adequate data, knowledge, and expertise on the ecological, silvicultural, socio-economic, and institutional dimensions of secondary forests. This affects and influences people's perceptions of the resource, masks its importance and potential, and often results in poor management, degradation, and inappropriate conversion.
f) The value of secondary forests has not been documented. Also, the rights of the people whose livelihoods depend directly or indirectly on their resources have not been recognised. This results in inappropriate conversion of secondary forests.
g) Participatory planning with local communities, the private sector, and NGOs – although necessary for effective secondary forest management – is often difficult to achieve. This negatively affects the role of the forest as a common property of local communities and its use in farm production systems. It also limits the provision of information on the roles and expectations of farmers and communities in relation to the forestry sector, and the identification of possible options for secondary forest management.
h) There is high pressure/demand by both humans and livestock on secondary forests. The high population densities often limit the restoration of secondary forests. Land pressure is forcing smallholder farmers to apply continuous cropping (FAO 2003). Land clearing for agriculture, which has become acute, coupled with high wood demand, has led to increased deforestation.
i) Factors such as past land-use, the proximity to seed sources, and the stage of successional development generate a high variability in productivity and species composition, which may complicate forest management (ITTO 2002).

18.6.2 Complementary Management Systems

Beyond the silvicultural methods for rehabilitation and restoration of degraded secondary forests, various other complementary approaches exist. Some are based on traditional systems with elements adapted to meet the specific requirements of natural site conditions and people, such as agroforestry systems or the use of improved and sustained NWFPs. Furthermore, new approaches have been identified and are ready to be introduced carefully, such as the tree outgrower system, which contains elements from taungya – a Burmese name for traditional shifting cultivation – and communal forestry. In this respect, the application of agroforestry systems, the valorisation of NWFPs, and the propagation of outgrower concepts can have major significance for the reduction of ongoing pressure on the diminishing forest resources.

Agroforestry in Secondary Forests in West Africa

Deliberate inclusion of trees in agricultural landscapes has been a common practice among the farmers of West Africa long before the term agroforestry was launched. Many farmers retained and planted trees on their farmland as part of their agricultural concept. Although many of the farmers had little or no scientific explanation for their practice, field experience convinced them to realise that planting or retaining trees on agricultural fields conferred some additional benefits, including provision of shade, shelter, energy, food, and fodder; maintenance of soil fertility, and provision of supplementary income.

Knowledge about the use of trees on farms was formally consolidated into the science of agroforestry, which has been defined as a dynamic ecologically based natural resource management system that, through the integration of trees in the farm- or range-land, diversifies and sustains production for increased social, economic, and environmental benefits for land-users at all levels (Leakey 1996). By this definition, quite a number of traditional agricultural practices existing in West Africa can be referred to as agroforestry. Notable among these are shifting cultivation with bush fallow, tree crop farming under shade trees, taungya, and permanent compound farming, commonly referred to as homegarden.

In the early days of agroforestry research, efforts were made to identify the various traditional farming practices that qualify as agroforestry and study them. With the emergence of agroforestry as a science, several efforts have been made to improve upon the traditional practices to cope with the challenges of increasing population pressures and food shortages. This has led to the design of several agroforestry systems, which were aimed at optimising the productivity of agricultural land. There has been a gradual transition from the early traditional agroforestry practices, which were more complex in structure and function, into simpler and more intensively managed systems. For example, Kang and Wilson (1987) gave an account of the gradual transition from the traditional shifting cultivation system into alley cropping with the challenges of increasing need for food.

Recently, scientists have come to the realisation that over-simplification of agroforestry systems portends danger to biodiversity and secondary forest development. This has stimulated renewed interest in traditional and complex tree-based land-use practices.

Simple Versus Complex Agroforestry

Agroforestry is an alternative land-use system developed to deal more effectively with problems of natural resource degradation, rural poverty, and environmental deterioration. It is an approach for improved land-use by integrating woody perennials with herbaceous or root crops and/or with livestock to achieve a variety of biophysical and socioeconomic benefits not attained with conventional, more segregated production strategies. Agroforestry practices produce food, fodder, fibre, and fuel supplies jointly, rather than separately, arresting and reversing soil losses and improving livelihood security. Agroforestry can contribute to the conservation of germplasm diversity of tree crop species and to the maintenance of niches for fauna and flora in the agricultural landscape (Michon and de Foresta 1995). On the basis of the structure (components) of agroforestry systems, different types can be distinguished. But unlike in the classification by Nair (1993), which considered types and arrangements of components, Michon and de Foresta (1995) used vertical stratification and the number of components as the basis for classification. They identified:

(i) complex agroforestry systems that look like and function as natural forest ecosystems
(ii) simple agroforestry associations, such as alley cropping or hedgerow inter-cropping systems, and grid inter-cropping.

While the complex agroforestry systems are multilayered or multistrata ecosystems, only one or two layers can be recognised in the simple agroforestry system. These simple systems contain a few components, usually not more than five tree species and an annual food (maize, cassava, rice) or tree crop (cocoa, coffee); whereas in complex agroforestry systems, a high number of components are intimately associated. The complex agroforestry systems tend to "mimic" the natural ecosystems more closely and are usually referred to as agroforests. Michon and de Foresta (1991) state that such complex agroforestry systems contain a high faunistic and floristic diversity that is comparable to primary forests or old secondary forests. Simple agroforestry is often dominated by agricultural crops like maize, rice, cocoa, coffee, and hence are of more interest to the agriculturists. The dominance of tree components, of high plant diversity, and of forest-like structure and functioning makes complex systems more interesting for forest scientists than for agriculturists.

McNeely and Schroth (2006), in a review on biodiversity impacts of traditional agroforestry practices from Central and South America, Africa, and Asia, concluded that traditional, often complex, agroforestry systems are more supportive for biodiversity than monocrop systems. They stated, however, that complex agroforestry systems are not substitutes for natural ecosystems.

Role of Shifting Cultivation in Secondary Forest Development

One of the earliest agroforestry practices in most parts of West Africa is the traditional system of shifting cultivation. The early farmers discovered that freshly cleared forest land produces good harvest, and this resulted in this traditional farming practice. In the shifting cultivation system, a cropping period is usually followed by a period of abandonment during which, according to the local farmers, the land is allowed to "rest." This results in a rotational arrangement of the cropping phase and a fallow phase. During the cropping phase (2 to 3 years), the farmer cultivates varieties of arable crops, while the fallow phase (usually >10 years) is characterised by abandoned farmland on which trees and other wild vegetation grow. Many of the secondary forests of West Africa owe their origin to this practice. According to Corlet (1995), the clearance, cultivation, and abandonment of tropical forest lands have resulted in a rapid increase of secondary forests in the area.

Under traditional shifting cultivation, a natural fallow is allowed to develop. Re-colonisation by plants occurs without any human interference. The general fallow re-colonisation pattern in the humid regions of West Africa has herbaceous grasses and broad-leaved species as dominant during the first two to three years, during which they are interspersed with seedlings, root shoots, or coppice re-growth of trees and tall shrubs.

The natural fallows in the humid West Africa can be described as young secondary forest that restores the productive capacity of the soil. The length of a fallow period determines the level of maturity of the resultant secondary forest. After a fallow period of 15 years, large trees, such as *Albizia gummifera*, *Anthocleista vogelii*, *Diospyros confertifolia*, *Funtumia elastica*, *Nauclea diderichii*, *Lophira alata*, *Brachystegia* spp., *Khaya ivorensis*, *Triplochyton scleroxylon*, *Ficus* spp., *Cola* spp., *Celtis* spp., and *Antiaris* spp., could have been recorded in lowland secondary forests of West Africa (Okigbo and Lal 1979).

A modern version of the shifting cultivation system – the improved fallow system – has been developed by agroforestry scientists in response to the challenges of increasing population and food shortage. Fast growing, usually nitrogen-fixing, tree species are deliberately introduced to shorten the fallow period and restore soil fertility. Under this system, the fallow period can be reduced to two years only. The resultant fallow vegetation is usually less complex and contains fewer species of trees. Although there are reports of wide acceptance of this practice in Kenya and some other African countries, it is yet to gain wide acceptance among the local farmers in West Africa, where the majority are still practising the traditional system with extended fallow period.

Contributions of Multi-Strata Agroforests to Secondary Forest Development

There are many forms of complex agroforests that present a dynamic and efficient type of land-use. They involve a range of tree species, but they can be distinguished by the dominant ones, e.g., cocoa- and coffee-based agroforests, which play a major role as multi-strata agroforestry systems in West Africa.

The dominant cultural practice of cocoa production in West Africa involves planting the trees on forestland that has been selectively cleared and planted with various types of food crops for one or two seasons (Duguma et al. 2001). When land is cleared, indigenous fruit, medicinal, and timber tree species are deliberately retained, both for their economic value and to provide shade for the cocoa plants. As the cocoa trees and other components mature, the system evolves into a closed canopy multi-strata system that resembles natural forest, with most of the positive attributes associated with it. Finally, the system produces fruits and quality timber.

The traditional modes of natural resource management in Guinea have led to the establishment of coffee agroforests that enabled the conservation of many primary and secondary forest tree species. Penot and Ollivier (2009) report on analyses of agroforestry systems in Ghana, where 11 high-value native forest tree species were identified in traditional agroforests. In other examples, exotic tree species like rubber (*Hevea brasiliensis*) are combined with coffee (Côte d'Ivoire) or cocoa (Ghana, Côte d'Ivoire).

Although agroforestry systems are more permanent than shifting cultivation, the abandonment of the site, which may be as a result of soil impoverishment, pests, plant diseases, or low prices, enables its re-development into forest. Large areas of secondary forest have developed this way in many areas of West Africa. The resultant secondary vegetation usually contains individuals of long-living crop plants, such as oil palm and fruit trees, which are relicts of past cultivation. Oke and Odebiyi (2007) recorded 487 non-cocoa trees belonging to 45 species and 24 families in 21-ha cocoa agroforests surveyed in Ondo State, Nigeria. A dominance of fruit tree species was noticed, with *Elaeis guineensis*, *Cola nitida*, *Citrus sinensis*, *Mangifera indica*, *Anacardium occidentale*, *Psidium guayava*, and *Persea americana* and others. The agroforest environment enables spontaneous colonisation by forest species after abandonment, which results in rapid development of secondary forest.

It can be concluded that agroforestry as a traditionally applied land-use system has a high degree of perception and acceptance among the rural population in West Africa. Although the use of agroforestry practices may have decreased in some places in favour of intensified agriculture, the combined use of tree and agricultural elements harbours so many advantages that this type of land-use has the highest potential to be increased. Agroforestry should be seen as a primary option for sustainable land-use in the future. New elements and developments in agroforestry research, as provided by the World Agroforestry Center (ICRAF) and their regional offices and networks, should be adequately followed up by extension services, evaluated for application under the specific site conditions, and later on put into practice in a participatory and sensitive way.

The Role of NWFPs in Secondary Forests

It is generally acknowledged that NWFPs in secondary forests have a high potential to contribute to the sustainable use of forest resources, the preservation of biological diversity, and the socio-economic situation of the local population (de Beer and McDermott 1989, Tropenbos 1999, Ros-Tonen 2000). The central hypothesis states: When forest dwellers recognise the economic value of their environment, they are interested in sustainable use of the forests. This will simultaneously contribute to the protection of the environment, opens income possibilities to local people, and can improve their livelihoods. In the case of secondary forests, it is furthermore anticipated that the use of NWFPs will either contribute to the restoration process or at least stop further degradation of the forest.

A vast number of NWFPs are found in the West African forests. Some are scientifically explored, widely cultivated, and top-ranking on national or international markets, such as cocoa, coffee, gum Arabic, and palm oil. Some are only locally used with low economic value, while others own a potential that only waits for discovery. In West Africa, the potential of NWFPs is widely underestimated and their value should be assessed with priority (Parren and de Graaf 1995). The following two examples highlight the potential, but also the limitations of the expectations in NWFPs.

The Case of Shea Butter

The shea butter tree (*Vitellaria paradoxa*) – called karité in francophone regions – belongs to the Sapotaceae family. It is widely distributed in semi-/dry forest formations and savannahs of West, and parts of Central, Africa. The deciduous tree can grow up to a height of 20 m, starts flowering after 20 years, and produces nuts that consist of a thin, tart, nutritious pulp that surrounds a relatively large, oil-rich seed from which a paste is extracted. Full yield is reached when the trees reach 30 to 50 years of age.

A number of steps is required to process the seed and obtain shea butter. Once shelled, the seed is roasted and either ground or pressed. After a cooking process with water, the shea oil can be skimmed from the surface. The locally manufactured paste is used for the production of soaps, candles, and cosmetics (Irvine 1961). Apart from its domestic importance, shea butter is also a commodity that receives growing attention on the international markets. In 2005, the world market price per metric tonne of raw nuts was USD190, crude butter sold for USD 450, and refined butter for USD 900. In 2007, the farm gate prices for raw nuts had risen to approximately USD 250 per tonne in the Ashanti region of Ghana. The shea butter as the end product is seldom traded because it is impure due to low processing standards. Several countries in West Africa already export 60 000 to 80 000 tonnes of shea nuts each year, but the potential is estimated at being 10 times higher. Important buyers include international cosmetic producers like L'Oreal, L'Occitaine, and The Body Shop.

Inventory results from a semi-dry forest heavily degraded by fire in the Ashanti region of Ghana, which has mainly served for charcoal production, show a high grade of adaptation of *V. paradoxa* to the disadvantageous growth conditions (Struwe 2009). The species has high rates in frequency, abundance, and natural regeneration, thus providing a good precondition for the use of the resource for shea butter. The present production of the commodity is for subsistence only. Organised harvesting, basic machinery for processing the nuts, and wise marketing of the final product are widely missing.

In one case, a local company with high social responsibility and with international financial and advisory support, introduced a self-help system for marketing shea butter in the region. Women's groups were organised for harvesting the fruits and, with small investments, basic processing plants could be purchased. The marketing activities were supported by international experts. The involved local people have had high expectations of these activities and now value their forest as a precious resource that must be safeguarded from harmful incidences in the future, such as fire. Although it is too early to draw a final conclusion, it can be attested that no destructive fires have occurred in the *V. paradoxa* areas since the start of shea butter activities five years ago. Furthermore, it can be concluded that a change in the perception of the population in relation to the utilisation of "their" forest has taken place.

The Cane Rat Case

Fire is often deliberately set to the transition forests of West Africa by local hunters as a prey-chasing method. The main target prey is a cane rat, also called "grasscutter" (*Thryonomys swinderianus*), whose bushmeat is highly esteemed throughout the region. The animal is a wild herbivorous rodent of subhumid to semi-dry areas in Africa south of the Sahara. The grasscutter meat is an important source of animal protein for rural people, where access to this type of diet is scarce. Therefore, the meat is welcomed as enrichment of the diet as well as a source of cash income and a product for trade. Its demand is generally higher than the supply on the markets.

The fires often run out of control and cause substantial harm to the environment. Ongoing fragmentation and degradation are evident consequences in the remaining savannah forests. Existing high-value timber plantations, mainly Teak (*Tectona grandis*), are also affected by fires, resulting in growth reduction, loss of biomass, or even complete destruction of forest stands.

The introduction of a grasscutter rearing system to local farmers appeared to be a promising approach for the prevention of fires. Furthermore, it was anticipated that a functioning grasscutter breeding system would contribute to the improvement of food security and the development of income sources, thus helping to alleviate poverty.

In Benin, grasscutter animals were trapped alive and selected for rearing. After promising breeding results, animals were distributed to other countries in the region where agricultural aid organisations implemented training programmes for interested farmers. Trained farmers were finally provided with a few animals to start breeding. Extension staff supervised and monitored the activities.

In a study in Ghana's Ashanti region, results showed a general low interest by local farmers in grasscutter rearing. No reproduction occurred in three years. Many of the distributed animals died due to inadequate rearing conditions and negligence. Instead of breeding activities, agricultural and partly also agroforestry practices, received more attention and acceptance by farmers. This may result from the cultural background as the Ashanti people are not cattle breeders by tradition and have no experience with indoor breeding of animals. Although the frequency of wild fires decreased during the study period, it came out that this was a result of newly introduced agricultural practices and not due to decreased hunting activities. The grasscutter rearing project in the study area was assessed as a failure and was consequently abandoned (Schroeder et al. 2007).

These two examples show that people and the environment can only benefit from the valuation of NWFPs as long as the commodity is in line with people's perception, tradition, and needs. It is a bitter experience of many development aid projects that no measure can be implemented successfully and sustainably against the willingness of all parties involved. Only when people's interests are adequately taken into account can a win-win situation that is rewarding to both the people and the environment be achieved.

NWFPs that are not yet established on the national or international markets provide valuable prospects for future utilisation and further valorisation of the environment. The shea butter case study can be seen as a typical example of many positive effects that can be derived from a NWFP with exploitation potential. The application of research findings and the provision of sensitive advice can act as catalysts for self-developing processes, such as the establishment of collection-, processing-, and marketing-associations on village levels.

Prominent NWFP commodities like cocoa, coffee, gum arabic, and others have already reached a high level of organisation along the whole production chain. But improvements are also possible here, such as through the introduction of genetically enhanced plant material and improved market access.

Although NWFPs have high potential, they are definitely not a panacea for all situations. A model that is successfully applied in one place can be a failure in another location. Sensitivity to cultural aspects in combination with good site knowledge is essential for the successful introduction of new NWFP practices.

The Forest Outgrower System

The forest outgrower system is a type of partnership between people who grow trees and timber buyers or processing companies. The main driver of this system is usually a company with inadequate forest holdings, insufficient access to public forests, or unmet demand for raw material. The enterprise seeks to secure additional supply to meet the increasing demand for wood products by signing partnerships between farmers to allocate land and other resources to the production and management of trees (sometimes other forest products) and the company, which provides a guaranteed market. The varying responsibilities of each partner are defined by contracts (Desmond and Race 2003).

A wood processing company in the Ashanti region of Ghana, which has a strong demand for timber to produce electric power poles, was seeking new supply sources for teak (*T. grandis*) timber, which is the most wanted material. The Ashanti region is dominated by small scale subsistence farming with annual crops like maize, maniok, yam, beans, etc.

Surplus is sold on local markets to gain income. The yield and income of the farmers are constantly threatened by land and soil degradation due to annual fires and non-diversified agricultural systems.

In a participatory approach, agricultural advisors together with rural communities, identified the tree outgrower system as an option to open up new supply sources for the wood processing company and simultaneously improve the livelihood of the local rural population through income generation.

In the initial stage, interested farmers were trained in workshops in order to attain necessary working skills. Afterwards, they were supplied with teak seedlings for a minimal fee. The seedlings were planted on their land together with their preferred staple crops. All harvest products (crops, fruits, timber) belong to the farmer. The wood processing company has the documented right to be the first bidder for the timber when the trees reach the desired dimensions after 10 to 15 years.

The teak seedlings demonstrated extraordinary growth in the fields during the first three years, with an average height increment of 2 m per year. The impressive growth attracted more farmers to participate in the tree growing activities and led to multiplying effects. Village cooperatives were founded to support new members. The establishment of village nurseries was the next step towards increasing the economic activities on the village level. Farmers who wanted to grow teak had to pay for the seedlings. These earnings were deposited into a bank account for future investments and profit distribution.

Presently, three self-organised village cooperatives run outgrower schemes in the Ashanti region. The interest in the activity is ongoing, and fire occurrence has strongly decreased in the outgrower sites. It can be assumed that the interest in the system will increase even more when trees reach harvest dimensions and the timber can be sold. The expected revenues will be an additional source of income, reduce the dependency on agricultural production, contribute to the improvement of the living conditions, and act as a stimulus for the careful utilisation of the environment. In addition, the wood processing company can diversify its resource supply in the immediate vicinity. The euphoria that exists, at least among the participating villages in Ghana, might diminish while waiting for the trees to reach harvest dimensions, because the farmers are not receiving income during that time. The company should be aware of this and support farmers' engagement and stimulate their endurance through training measures.

Incentives for tree-growing activities other than under agroforestry systems are comparatively new at the village level in West Africa. The outgrower system is a promising approach between sectors that usually have no common objectives. But preliminary results of this type of collaboration give space for cautious hope in the future. Further development or the introduction of other systems appears to be possible. Penot and Ollivier (2009), for example, suggest the introduction of the Indonesian jungle rubber system to western Ghana. Under this system, rubber trees are planted on slash-and-burn sites together with agricultural crops. After abandonment of the agricultural production, the site gradually converts into secondary forest enriched by rubber trees, which can be tapped and the commodity sold. In Sumatra and Kalimantan, 2.5 million ha of these rubber forests exist. Seventy percent of Indonesian rubber exports originate from such smallholder farms (Penot and Ollivier 2009).

Jobst-Michael Schroeder

Photo 18.2 An outgrower in his agroforestry plot under 2-year old teak trees (*Tectona grandis*), which are cultivated together with maize and yam (Ashanti region, Ghana).

Smallholder or village tree plantation activities can become an additional asset for the reduction of natural resource utilisation. Fast-growing tree species are suitable for energy plantations from which wood can be harvested after short growing periods. The high demand for energy in many parts of West Africa creates an enormous potential for the production of charcoal – the most used source of energy. The harvest from sustainable resources in combination with improved kiln techniques could generate income, curtail illegal logging activities, and reduce pressure on the remaining forests (Bisiaux et al. 2009).

18.7 Conclusions and Recommendations

The global trend of forest loss with a net reduction of 7.3 million ha per year is still occurring at a steady pace (FAO 2006). The extent of primary forests has been drastically reduced, with the exception of very remote areas or effectively protected forests. Consequently, the area of secondary forests is constantly increasing. A growing world population is competing globally for diminishing land resources to secure agricultural production and to meet energy demands. The internationally progressing land grabs that encompass the lease or purchase of huge areas for agricultural production by international companies in developing countries symbolise the precarious situation for competition for productive land. Under these conditions, the chance to avoid further losses of tropical forests and to halt degradation seems to have only limited prospects.

In West Africa, secondary forests are under extreme pressure and experience strong degradation, fragmentation and clearance. Causes for the deterioration, or even conversion of these ecosystems are mainly triggered by the needs of rural populations for food and other daily necessities. Today, national and international efforts aim to preserve and restore the remaining forests to safeguard their manifold functions. Furthermore, only forest ecosystems with a minimum of intact biological functions can uphold or slow down the desertification process, which is progressing southwards from the Sahel zone.

Due to the rapid expansion of secondary forests, together with a deterioration of their environmental services, it is an urgent requirement to develop new sustainable management approaches that adequately address the needs of all parties involved. To accomplish this, it is necessary to apply holistic approaches that equally take into consideration people's livelihood needs, cultural aspects and values, as well as site-specific management practices and silvicultural options. The above examples highlight the potential of agroforestry, the value of NWFPs, and the chances of new land-use approaches such as the outgrower system as complementary assets for the silvicultural management and sustainable development of secondary forests. There is additional economic potential in the use of lesser-used tree species, income generation from environmental services, and carbon sequestration, to mention just a few options for secondary forests that should be further explored and promoted.

It is strongly needed that new and complex secondary forest management strategies will be developed. These should be accompanied by multidisciplinary research that is practice-oriented and can contribute to solutions for current and future problems. Research results should be incorporated into management plans, thus constantly improving the strategies. Sustainable secondary forest management is a big challenge for everyone involved, but it provides opportunities for better use of the resource and conservation of the environment for the future.

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