# CHAPTER 8

# TREE PLANTING AND NATURE CONSERVATION

## CHAPTER OUTLINE



## 8.1 INTRODUCTION

This chapter looks at the implications of tree planting, whether on farms or in plantations, for nature conservation. We have already seen that deforestation and poor management of natural forests is generally very harmful for nature conservation. But what role does tree planting have in nature conservation? Are plantations good substitutes for natural forests? To what extent does tree planting help environmental conservation generally, and nature conservation in particular?

## 8.2 BIODIVERSITY IN PLANTATIONS

### 8.2.1 Environmental impact of plantations

In many parts of the world, natural forests are being replaced by plantations. How will this affect nature conservation and the environment generally? The main point to note is that plantations are undoubtedly far less important for nature conservation than natural forests. The degree to which they differ in their importance depends on a number of factors. In each of the following factors, the first option is likely to have more adverse impacts, or fewer positive impacts, on nature conservation than the second:

- Whether plantations are established (a) directly on land cleared of natural forest for the purpose, or (b) on land from which natural forest was cleared some time before, such as farmland or degraded forest.
- Whether plantations replace (a) all natural forest or (b) only a proportion of it.
- Whether plantations are of (a) single or (b) many species.
- Whether plantations are (a) managed on short or (b) long rotations.
- Whether plantations are composed of (a) exotic or (b) native species.
- Whether plantations are (a) heavily weeded to exclude competing vegetation or (b) not.
- Whether the plantation is in its (a) first or (b) subsequent cycle of planting.

The greatest harm that plantations can do is if they replace natural forest. About 15% of tropical plantations have been established at the expense of natural forest (Postel and Heise, 1988). More general adverse environmental effects of plantation establishment are many. Some that apply particularly to afforestation of formerly open land are given in Box 8.1. Note, however, that there can also be many beneficial effects, discussed later in this chapter.

There are many ways in which plantations can be enhanced so that they are better places for wildlife. Some of these are listed in Box 8.2. The issue of whether to plant exotics or native species is not as contentious, from a nature conservation point of view, as some environmentalists have made out, since a plantation will nearly always have low intrinsic nature conservation value whether it is composed of native species or exotics.

**Box 8.1**
**Some possible adverse environmental impacts of plantation establishment, especially on previously open land. From ODA (1992b)**

- Depletion of ground water. Trees intercept rainfall and have a large appetite for ground water which disappears in evapotranspiration. They can lower the surrounding water-table, which might be to the detriment of other species, wells and agriculture, although species vary widely in this respect.
- Trees provide a habitat for pests, predators and disease vectors, as well as for beneficent animals.
- Forests may increase the risk of fire.
- The introduction of new tree species, or changing the balance between existing ones, will alter the ecosystem.
- Fast-growing pioneer species whose valuable attributes, such as ability to colonise deforested and degraded land, may be offset by less desirable traits. These include reduction of soil moisture/soil fertility, suppression of other vegetation, and invasiveness (i.e. tendency to invade farmlands or replace natural vegetation).

There is justifiable concern, however, about invasive exotics (see Section 8.4), but this is more an issue of where the plantation is located rather than whether exotics should be used *per se*. Finally, there is also justifiable concern that exotics will one day be vulnerable to pests or diseases introduced accidentally or deliberately. This is a valid concern, but it is not really a conservation argument.

In areas where it is considered important to use native species in plantations, the following species are just a few of many native to Uganda which may prove useful (from Struhsaker, 1987 and Hamilton, 1984):

- *Sesbania sesban:* for firewood and as a nitrogen-fixer;
- *Markhamia platycalyx:* especially for poles;
- *Maesopsis eminii:* for timber;
- *Cordia millenii:* for timber;
- *Khaya anthotheca:* for timber, but can suffer from shoot borer (*Hypsipila* spp.) in plantations, and not native along Lake-shore;
- *Milicia excelsa:* for timber, but can suffer from gall-fly (*Phytolema lato*) in plantations in southern Uganda, although not in the north.

### 8.2.2 Plantations versus natural forests

If natural forest is replaced by plantation, this is a great loss to nature conservation. But if plantations are developed on land formerly under some other use, then the implications for nature conservation may be positive, neutral or negative. In practice, plantations are only really of any value for nature conservation if there is no natural forest with which to compare them. In any studies that have compared plantations with natural forests, the latter always emerge as being far more important.

**Box 8.2**
**Some methods for enhancing the nature conservation value of plantations. After Sawyer (1993)**

- Extend rotation periods on specified areas to allow "old growth" to develop and to encourage the growth of natural vegetation.
- Retain corridors of the original natural vegetation throughout and alongside plantations, and linked to reserves (unless the planted species is potentially invasive).
- Leave ground near to water-courses unplanted: areas which are of marginal production value, such as gullies, stream buffers and steep slopes, are often of high conservation value.
- Allow an understorey to develop, so that cover and a continuous source of food for birds and mammals are provided.
- Manage harvesting and tending operations in such a way that minimises habitat disturbance.

For instance, during courses held at Nyabyeya Forestry College in 1993 and 1994, participants were asked to survey a pine plantation growing near Budongo Forest and assess its value for biodiversity conservation. Although the techniques employed were rather basic, during all the courses no more than about fifty plant species were recorded from the plantation. This compares very unfavourably with the 855 or so recorded from Budongo Forest by Synnott (1985). On the other hand, a study of moth diversity in a eucalyptus plantation in Sabah, Malaysia, reported recently by Tickell (1995), concluded that the plantation under investigation had nearly as many species (800) as nearby selectively logged secondary forest (1000).

The difference between this finding and that quoted above is probably due to the species-group investigated (perhaps moths are more mobile than plants), to the differences between pine and eucalyptus in the amount of natural vegetation that survives beneath the canopy, and probably also due to the different histories of the plantations - that at Nyabyeya was planted on open land, whereas that in Sabah was almost certainly planted directly on purposely-cleared natural forest.

Figure 8.1 shows the numbers of bird species recorded during a study of native montane forest and exotic coniferous forest in the Kenya highlands.

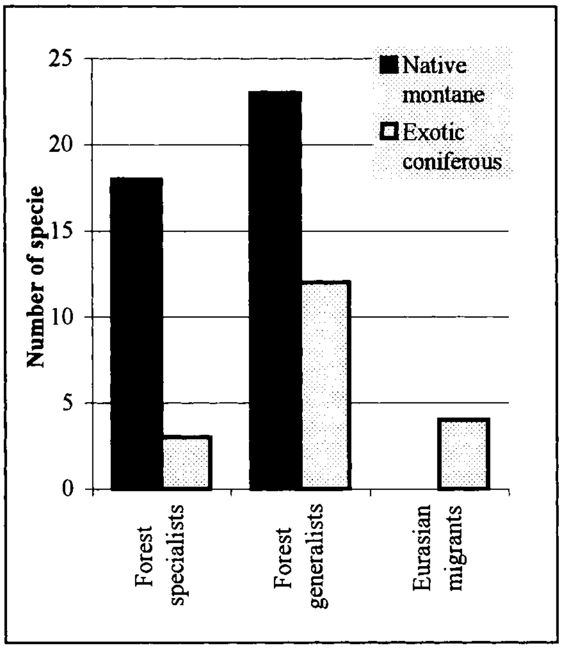


*Figure 8.1. Bird species found in two areas of forest, one native and the other exotic, in the Kenya highlands. After Carlson (1986).*

The birds are divided into three groups: forest specialists, forest generalists and Eurasian migrants. Native forest is shown to support far more species in the first two groups (five times the number and double the number respectively). Coniferous forest appears to support more species of European migrant birds, however, although presumably these species are not dependent on this forest type being present in the tropics, because it has only been around for a few decades and yet the birds have been migrating for millennia.

A further study, this time from Uganda, looks at the number of bird species recorded from different categories of land around Kibale Forest (Figure 8.2). Again, natural forest is seen to support far more species, particularly forest specialists, than any other land use category; indeed, even cultivated land seems to support more species than any form of plantation in the area. Interestingly, eucalyptus plantation seems to be far more valuable for forest birds than pine plantation, which has fewer species even than tea plantation. The original study (Pomeroy and Dranzoa, unpubl.) also investigates bird density, and concludes that densities of birds in plantations are normally far lower than in natural forest, particularly for forest specialist species.

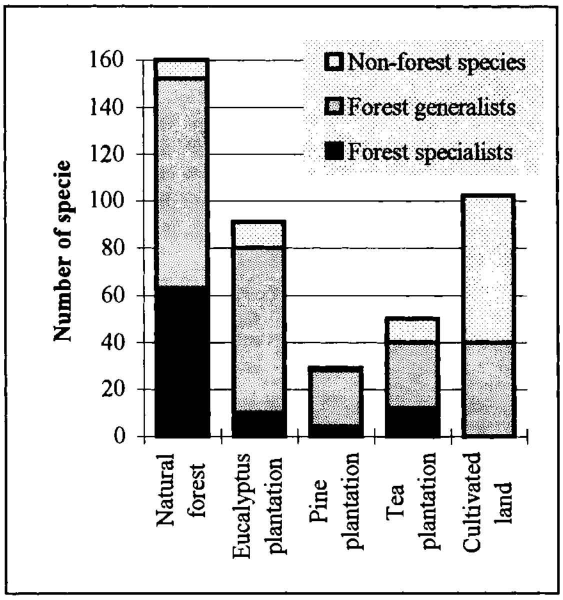


*Figure 8.2. The numbers of bird species recorded from various land-use types around Kibale Forest, Uganda. After Pomeroy and Dranzoa (unpubl.).*

## 8.3 REDUCING PRESSURE ON NATURAL FORESTS BY PLANTING TREES

Plantations have low intrinsic value for nature conservation. But this does not make them irrelevant to conservation. The main conservation argument in their favour is that, as human consumption levels escalate, they can help to take pressure off the exploitation of natural forests. Trees planted on farmland could also do the same.

Let us look at this argument in a little more detail.

### 8.3.1 Plantations and biomass yields

To understand the value of plantations as sources of fuelwood, we must first compare them with other potential sources, including natural forest.

Figure 8.3 shows the standing stock of woody biomass thought to be present in various types of woody vegetation. From this it seems that coniferous plantations have more woody biomass than deciduous plantations, but slightly less than intact tropical moist forest. At first sight, this suggests that tropical moist forest is a better source of woody biomass, but the chart also suggests that, once depleted, tropical moist forest has relatively low value compared to coniferous plantations (see Section 6.5.2 for why this might be so). Other woody vegetation types, including woodland, scrub and grassland, have much lower standing stocks. Note, however, that the figure shows **standing stock**, not **productivity**: coniferous plantations have a twenty-to-thirty year turnover period, whereas crop residues from farmland, for instance, could be harvested twice a year. On the other hand, perhaps 80% of a plantation tree's woody biomass could be used as fuelwood, whereas only 25% of crop residue could be (Turyahikayo, 1994).

## 8.3.2 Supply and demand for timber and other wood products

### *8.3.21 Supply*

Plantations and trees planted on farmland cannot provide all the products of a natural forest, but they can provide some of them, for instance fuelwood and sawn timber. Demand for both these products is rising. At the same time, the supply of them from natural forest is falling, since the area of natural production forest is falling (either because of deforestation (see Chapter 1) or because forest is taken out of production).

Figure 8.4 shows predictions of the annual yield of timber available from Uganda's natural forests and plantations for the period 1985-2000. Note that the yields from plantations are almost as large as the yields from natural forest, despite the much smaller area of plantation. This is because plantations have much higher mean annual increments: in Uganda, something in the order of $15 m^3/ha/yr.$ (Plumptre and Carvalho, 1991), as opposed to 1 or 2 $m^3/ha/yr.$ for natural forest. [Note that some hybrid eucalyptus plantations in Brazil even yield 70 $m^3/ha/yr.$ (FAO, 1994)]. Even so, it is clear that the amount of timber available has been declining, and this decline looks set to continue unless planting rates increase.

### *8.3.22 Demand*

On the other hand, demand looks set to increase. Figure 8.5 is based on predictions made in the 1970s, and suggests that Uganda's consumption of wood products is growing rapidly. At the time, it was predicted that the only wood product whose consumption would decrease would be that of firewood in the monetary sector, since it was felt that, over time, people would adopt other means of cooking and heating; but so far, this has scarcely happened. The booming housing construction sector is consuming an increasing proportion of sawn timber and poles. By the year 2000, it is estimated that Uganda will need nearly 4 million new homes (Ministry of Energy, Minerals and Environment Protection, 1991). As Figure 8.6 shows, the predictions for Uganda are broadly in line with reported levels of consumption in Africa as a whole.

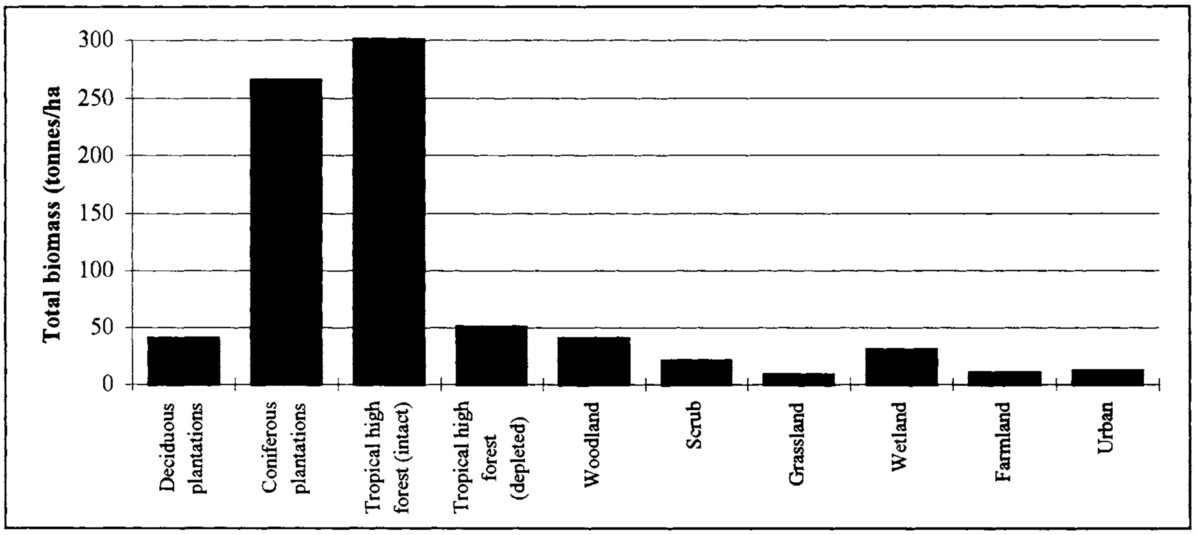


*Figure 8.3. The standing stock of biomass for main types of land cover in Uganda. After Turyahikayo (1994).*

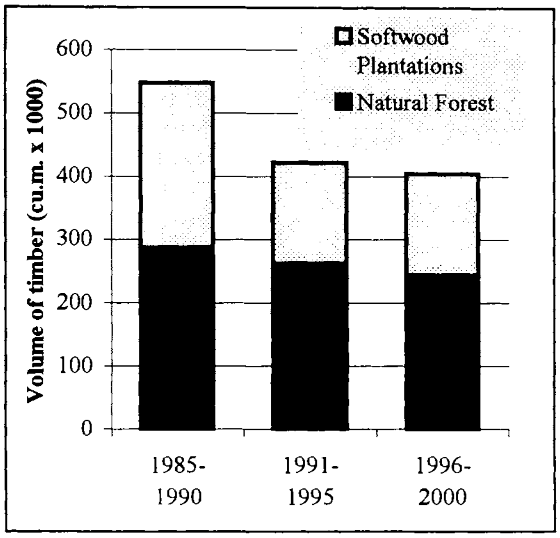


*Figure 8.4. 1985 predictions of annual yields available from Ugandan forests.*

### *8.3.23 The gap between supply and demand*

There is an increasing gap between demand for wood products and their supply. This is as true for timber as it is for fuelwood: several former major timber exporting countries (such as Nigeria) have now become net importers, as domestic supplies have been exhausted. Will Uganda, once an exporter of timber, go the same way? Mahogany is already imported from Zaire. Even in the 1950s, Dawkins (1958) wrote that "*...to reach [the necessary level of production of sawn timber in Uganda] within fifty years is extremely ambitious, and is probably beyond the capacity of the tropical moist forest however skilfully managed...*", implying that, unless many more plantations were established, Uganda would have to import timber. Similarly, Lockwood (1973) recommended that either the natural forests would have to be harvested a lot more intensively (and therefore unsustainably) to meet the short-term needs of the country, or the area of tree plantations would have to be expanded tenfold if Uganda was to satisfy its requirements for wood products in the year 2000. [The first recommendation was taken up during the Amin years, but, fortunately from a conservation point of view, the sawmills deteriorated faster than the natural forests (Karani, 1994)]. The gap between coniferous sawn-wood and paper/board production and consumption seems to be widening throughout the tropics (Brooks, 1993). Globally, the world's tree plantations provide only 7%-10% of the world's commercial wood consumption (FAO, 1994).

About 58% of all energy consumption in Africa is met by fuelwood: by far the highest proportion in the world (the global average is only 5%) (FAO, 1994). Fuelwood supplies in many African countries are now thought to be inadequate to meet this demand (see Figure 8.7). The rate of consumption of fuelwood in Uganda is 40 times that of sawnwood (FAO, 1989a). Although talk of a "fuelwood crisis" seems to be moving off the political and environmental agenda, Kenya already imports charcoal from Uganda, much of it collected illegally from natural forest reserves; meanwhile, people in Tororo district, near the Kenya border, have had to change their eating habits to cope with fuelwood scarcity, as have people in Kabale district, where many families now only cook once a day.

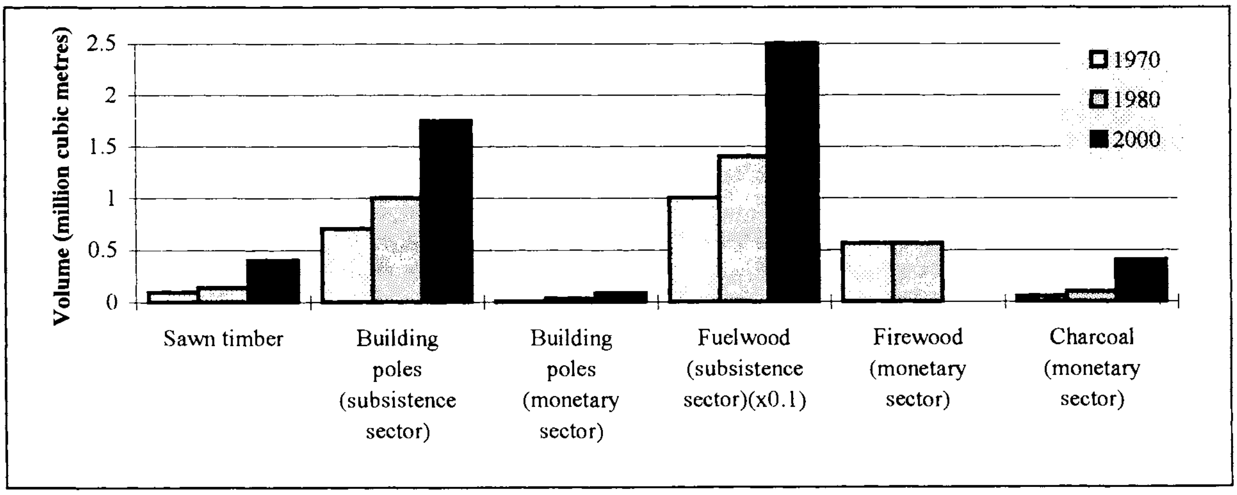


*Figure 8.5. Production in 1970 and projections to 2000 for consumption of various wood products in Uganda. After Lockwood (1973) and Hamilton (1984). Note that the charts for fuelwood (subsistence sector) have been shortened by a factor of ten so that they can be presented on the same graph as the other wood products, while the charts for charcoal refer to million tonnes, not million cubic metres.*

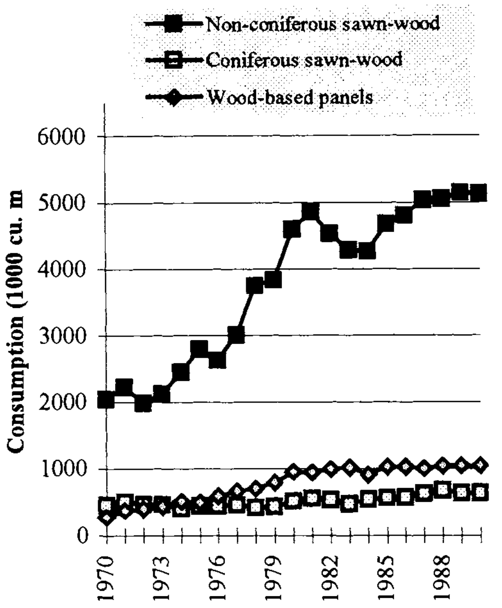


*Figure 8.6. Apparent consumption levels of three types of wood products in Africa, 1970-1990. From FAO AGROSTAT statistics, in Brooks (1993).*

### *8.3.24 Closing the gap*

The gap between supply and demand could theoretically be closed in two ways:

- by increasing supply (for instance, more plantations, woodlots and trees on farmland); and
- by reducing demand (for instance, improved fuel efficiency).

#### *Increasing supply*

Globally, the area of planted forest has increased greatly in recent years, but most of this has been in temperate countries. In the tropics, there have been substantial increases in Latin America and the Asia/Pacific region, although much of the increase in the latter area has been on land cleared of natural forest specifically to establish plantations. In Africa, by contrast, there has been hardly any growth. Figure 8.8 shows the trend for the humid tropics; the situation in drier areas is probably not that different. Overall, there are about 30 million hectares of forest plantations in the tropics, an area which is rising by about 2.6 million hectares annually (FAO, 1994), of which only 90,000 hectares (5%) is planted in Africa (ITTO, 1993). Although 30 million hectares sounds a lot, far more natural forest is being lost: the current ratio of natural forest loss to plantation establishment in the humid tropics is about 5:1 in Asia, 15:1 in Latin America, and 30:1 in Africa (Whitmore, 1990). Africa currently has just 7% of the tropic's plantations (ITTO, 1993).

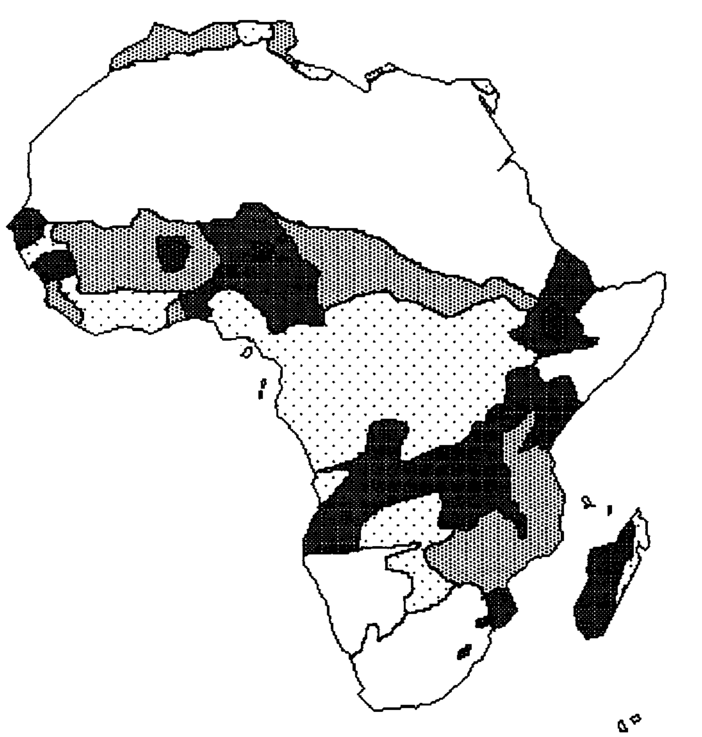


*Figure 8.7. The state of fuelwood supplies in Africa. FAO data, after Mather (1991).*

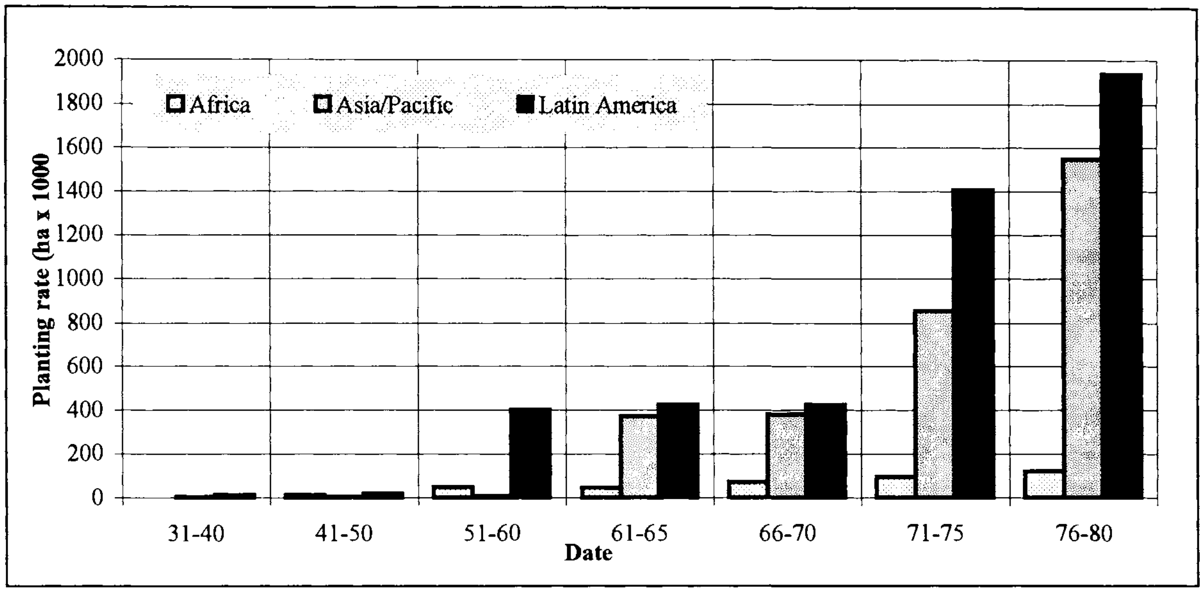


*Figure 8.8. Trends in planting rates of plantations in the humid tropics. After Grainger (1986).*

So at present, the increase in plantations is probably not even keeping pace with increase in demand in Africa, let alone closing the gap. This implies that natural forests continue to provide much of the produce instead, which is potentially very harmful for nature conservation if it goes beyond what the forests can supply sustainably. On the other hand, tree-planting on farmland seems to be increasing, at least in some areas, as more and more farmers become aware of the benefits of trees to them. The classic example of this is in Machakos district, Kenya, where there are now more trees on farmland than at any time in the last fifty years, even though human populations are now much higher (Lundgren 1993). In fact, in the 10 million hectares of high-potential land in Kenya, woody biomass on farmland increased by 4.7% per year, and the volume planted was found to be strongly positively correlated with human population density (Figure 8.9)(Holmgren et al., 1994). The authors of this study conclude that secure land tenure has been the key to this growth in planted trees. It is unfortunate for nature conservation, however, that in most areas farmers first clear natural forest (20,000 ha per year in Kenya), and then have to go through a period of tree scarcity before beginning to plant their own trees.

Already in Uganda a third of the standing stock of trees is on farms (Millington, 1994). However, there are very many reasons why Ugandan farmers do not plant trees, as Figure 8.10 illustrates. Most claim that they do not have enough land, a situation that is likely to get worse as populations increase.

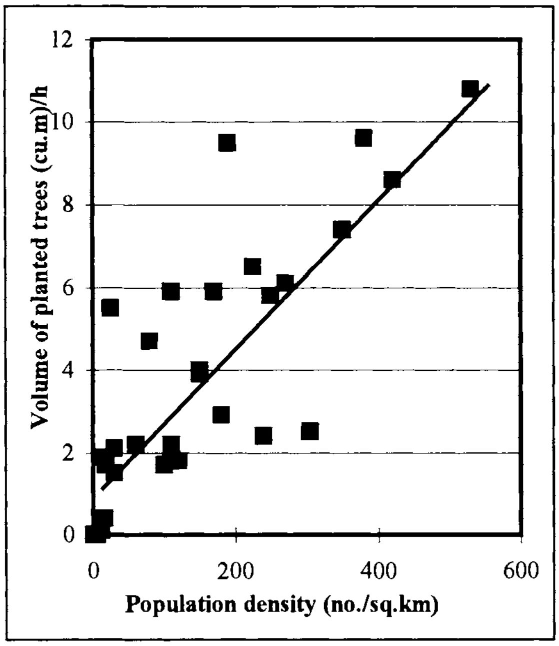


*Figure 8.9. Planted biomass volume versus human population density for districts in the high-potential areas of Kenya. Redrawn from Holmgren, Masakha and Sjoholm (1994).*

### *Reducing demand*

Reducing demand is potentially a more sustainable option (since sooner or later increasing consumption levels will exceed what the land can supply anyway). There is gross discrepancy in levels of consumption between countries of the developed and developing world. Whereas developing countries tend to use more fuelwood, developed countries use more timber.

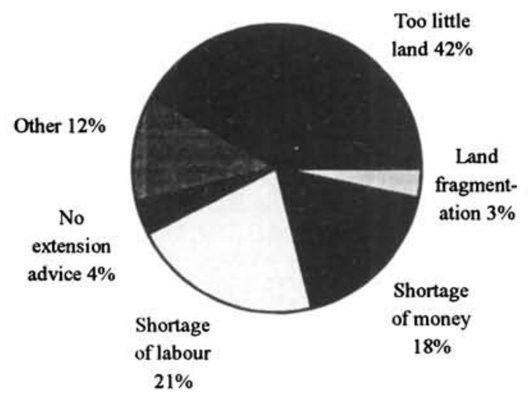


*Figure 8.10. Farmers' constraints to implementing policies on tree-planting, erosion control, and swamp and forest conservation, based on seven study areas in various parts of Uganda. After Tukahirwa (1992). The total of 88% suggests that only 12% of farmers are free from any of these constraints.*

According to Hurtado (1994), if everyone used as much wood as people in the Netherlands, then 11,000,000,000 $m^3$/yr. would be needed by the year 2010, a volume that could simply not be met by the world's forests, natural or plantation. Developed countries are only now beginning to wake up to this by starting to recycle wood and consume less. Fifty-five per cent of the global consumption of wood products is for fuel (Whitmore, 1990). In Uganda, 96% of the population cooks with firewood or charcoal (Karani, 1994), so theoretically the potential for making savings here by increasing efficiency of stoves and charcoal manufacture is vast. According to Struhsaker (1987), fuel conservation measures could be 2-25 times more effective at closing the gap between supply and demand than current levels of tree-planting, although much would depend on the level of uptake. Measures include the following (after Struhsaker (1987), and HBEW (1994)):

- Drying wood before burning it. This increases heat output, and could reduce consumption by over 20% (Struhsaker).
- Using improved fuel-efficient wood cooking stoves (Struhsaker). Some models can reduce consumption 5-10-fold; a "multipot" stove uses 7 trees per family per year, whereas a traditional 3-stone fire may use 12. If fuel-efficient stoves were widely promoted and uptake was twice what it has been in Kenya, then about 2.5% of current fuelwood consumption could be saved (HBEW).
- Using more efficient charcoal kilns. 50%-70% of wood's energy is lost in converting it to charcoal. Efficiency of conversion can be increased by 50% by using only dense, dry wood in uniformly sized pieces, and by packing the wood tightly and giving a thick earth covering to the kiln to prevent complete combustion (Struhsaker). If improved earth kilns such as the Casamance kiln were promoted widely, then about 2.5% of current fuelwood consumption could be saved (HBEW).

## 8.4 INVASIVE EXOTIC SPECIES AND CONSERVATION

### 8.4.1 What are invasive exotics?

The term ***exotic*** is widely understood by foresters to mean a species of tree that is not indigenous to the area where it is being grown. Many have been deliberately introduced because they have valuable characteristics that local species may lack; hence many of the most important plantation tree species are exotics. Examples in Uganda include the pines (mostly from Central America) and eucalypts (from Australia). Other plants and animals can also be described as exotics. Animal examples include chickens (from tropical Asia), turkeys (from North America) and goats (from the Middle East).

Many other exotics have been spread around the world by humans, either deliberately or accidentally. Most of them could not survive in their new home without the continued presence of humans either deliberately nurturing them (such as many crop plants) or maintaining the conditions necessary to their survival (such as agricultural weeds). But just a few species find the conditions in their new home good enough for survival without the help of humans, and establish ***naturalised*** or ***feral*** populations in the wild. Of these, a small proportion find conditions so suitable that they become more common in their new home than they ever were in their native home. When they start replacing indigenous species, we refer to them as ***invasive exotics***. There are now numerous examples of invasive exotic plants and animals throughout the world. Their spread causes economic as well as ecological problems.

### 8.4.2 Economic importance of invasive exotics

In the United States, for example, 4500 species of exotic plants and animals have established feral populations, of which about 15% can be classed as invasive exotics. Just 79 of the worst offenders are estimated to have cost the nation $97 billion this century (Kiernan, 1993). The introduction of Nile perch (*Lates niloticus*) to Lake Victoria has caused major changes in the fisheries there, and has been particularly damaging for traditional fishing communities. Recently, the spread of water hyacinth (*Eichornia crassipes*) has been causing further hardship for lake-shore communities. The leucaena psyllid (*Heteropsylla cubana*) has been decimating stands of leucaena (*Leucaena leucocephala*) throughout Asia and is now spreading through Africa; likewise the aphid *Cinara cupressi* on cypress in East and Central Africa.

### 8.4.3 Ecological importance of invasive exotics

Invasive exotics can radically alter the entire ecosystem and threaten many species with extinction. Bibby et al. (1992) estimated that 8% of all the world's threatened restricted range birds are threatened by exotics, while WCMC (1992) estimated that 21% of all the world's threatened mammals are threatened by exotics (see Section 3.3.3). There is no figure available for threatened plants, but invasive exotics are likely to be one of the largest threats. The way they do so will depend on what niche they occupy.

An invasive exotic **predator** may outcompete a native predator, causing it to go extinct. It may start to prey on species that have not evolved to cope with the new predator, causing extinction of those prey species too. As they disappear, so there may be further knock-on effects throughout the food web. A classic example is the case of Nile perch in Lake Victoria, introduced in the 1950s. The native fishes, including over 100 endemic tilapia species, were soon decimated by the new predator, and the whole ecology of the lake is now very different from before the introduction. Changes are still going on, and many extinctions are likely. FAO (1992) estimates that of the 300 or so species of fish that existed in the lake before the introduction of Nile Perch, about 200 have either disappeared or are threatened with extinction.

If the invasive exotic is a **herbivore**, the effects can be equally profound. Goats, rabbits and deer, introduced to islands around the world where no similar herbivores existed, have managed to convert forests to scrub and desert within a few centuries.

Invasive exotic **plants** have probably been responsible for most ecological damage, and this is the group that concerns us most in this chapter. Many have been introduced by foresters as potential timber, firewood, pulp or fodder trees, or as boundary markers. Sheil (1994) has listed 48 plant species which have become naturalised in the East Usambara mountains of Tanzania, some of which are causing major changes to the forest. Most were introduced by the Forest Department. Chief among these is *Maesopsis eminii*, which, although native in western Tanzania (as in western Uganda), is not native in the Usambaras. In the Usambaras, it is gradually replacing many of the native species (many of them endemic) because it is better at colonising gaps than they are. Binggeli (1989) estimates that within 200 years, *Maesopsis* could make up 50% of the forest canopy.

Other examples of invasive exotic plants include *Cecropia* sp., a South American tree that is ecologically very similar to *Musanga* and which is beginning to replace it in logged forest in Côte d'Ivoire; the trailing shrub *Chromolaena ochroleuca*, common in forest edges throughout West Africa, *Psidium guajava* and *P. cattleianum* (guavas), which are major causes of species extinction on many tropical and sub-tropical islands and are spreading in Ugandan forests too, *Spathodea campanulata*, a native of Uganda that is invasive in semideciduous forests in Sri Lanka, and the Asian *Azadirachta indica* (neem), is spreading in many parts of tropical Africa (Davidson, 1987).

### 8.4.4 Invasive exotic plants in Uganda

It is possible that *Maesopsis*, the main problem species in the Usambaras, may prove equally invasive in forests in Eastern Uganda, such as Elgon and West Bugwe, where it is also not native. Many other plants are causing concern in Uganda, although most are proving to be problems in plantations (such as *Toona ciliata*, *Cassia spectabilis* and *Cedrela mexicana*), grazing land (such as *Lantana camara*) or waterways (such as *Eichornia crassipes*, the water hyacinth). Fortunately, relatively few are causing problems in natural forest so far.

Three that are now causing concern in Budongo Forest are *Broussonetia papyrifera* (paper mulberry), *Psidium guajava* (guava) and *Cassia spectabilis*. Paper mulberry was brought to Budongo in 1953, when it was planted in Research Plot 41 near the Sonso sawmill (Dawkins, 1956). The experiment was designed to investigate the potential of paper mulberry for pulp production from its fibrous bark. Within a year, the trees had increased in height from 1.3 m to 7 m; a year later they had reached 12 m. The study concluded that paper mulberry "*...has shown the fastest growth recorded by any trees in Uganda...*", and recommended that "*...it should be tried further wherever there is any possibility of paper making near any rainforest blocks...*". It was also noted that the plot "*...will continue to be carefully watched...*", but unfortunately this did not happen. Paper mulberry has since started to spread, firstly into disturbed areas around the sawmill, but increasingly in gaps and along logging roads throughout the forest. In areas nearest to its original introduction, it is almost the only tree species present, and it is possible (but not proven) that it may eventually come to dominate large areas of Budongo.

In the case of guava, the species can now be found in many parts of the forest, and is sufficiently common for its fruits to be valued by local communities as a "wild" food (Johnson, 1993). Given its performance in forests in other parts of the world, it too could become a major nuisance. *Cassia spectabilis* was introduced by the Forest Department as a boundary marker (its crown shows up well in aerial surveys because of the yellow flowers), but has since spread along forest roads and into gaps. This same species has already proved highly invasive in Semliki Forest.

### 8.4.5 What makes some exotic plants invasive?

Of the many thousands of plant species that have been carried around the world by humans, few have become invasive. Whether they do so or not depends on a number of factors. An understanding of these should help foresters to avoid encouraging further invasive exotics in the future, and may help us to understand how best to tackle problem species. Box 8.2 lists some of the factors that make some species invasive and others not.

### 8.4.6 What should we do about invasive exotics?

We know that invasive exotics pose serious ecological and economic threats, and that historically we have not recognised the threats until it is too late. Many species have become invasive after their introduction by well-meaning foresters. With an understanding of what makes some species potentially invasive, we should be able to evaluate species with this in mind before deciding whether to introduce them or not. If we decide to introduce them, we may decide to keep them well away from any natural forest that might be invaded, or to ban their use as boundary markers around natural forest. Furthermore, armed with an ecological understanding of invasive exotics, we should be able to predict the best methods of limiting their spread (such as altering logging practices) and perhaps even suggest practical ways to eliminate them once they have become established. The costs of not doing anything can be high indeed.

## 8.5 SUMMARY

We have seen that, whereas plantations do not tend to have much intrinsic nature conservation value, planting trees is nevertheless important as one mechanism for helping to meet the increasing demand for wood products. In so doing, tree-planting takes pressure off the natural forests, which could otherwise not meet the demand without being grossly overexploited. Promoting efficiency in the use of woodfuel also has a role to play.

In some cases, it is true that tree planting also has broader environmental advantages, but there are often also disadvantages. We should be particularly aware of promoting the planting of any tree species that might become invasive in natural forest. Box 8.3 outlines some of the strategies that are likely to prove most successful, and environmentally sustainable.

Conditions under which establishing plantations would be inappropriate include where they are established on land of higher value for other social, environmental or economic purposes, especially where this is done by clearing natural forests (incurring high environmental costs) or by compulsory acquisition (incurring high social costs) (Kanowski and Savill, 1992).

**Box 8.2**
**Some characteristics that make some exotic species invasive and others not**

- **They are usually early successional species rather than climax species.** Thus disturbance increases the invasibility of plant communities (Hobbs and Huenneke, 1992). For instance, paper mulberry is a coloniser of forest gaps in its native habitat on the islands of the South Pacific. The forests there are naturally prone to high levels of disturbance by tropical storms, and paper mulberry is well adapted to responding to this disturbance. Logged forest in tropical Africa may mimic this natural disturbance, making successful colonisation by paper mulberry more likely. Likewise, in the East Usambaras, undisturbed natural forest now harbours 19 species of naturalised exotics, whereas disturbed (logged) forest and forest edge supports nearly twice as many (36) (Sheil, 1994).
- **They usually grow quickly**. Paper mulberry was described as the fastest growing tree in Uganda. Thus, once it colonises an area, it is good at out-competing potential rivals for space and light. This characteristic also means that invasive exotics can spread faster than we can control them.
- **They usually have abundant seed production**. Paper mulberry can flower more or less continuously throughout its adult life. Each "flower" is actually a group of flowers, and the "fruit" therefore contains many seeds.
- **They usually have short generation time**. Paper mulberry starts flowering within two years.
- **They usually have good long-distance seed dispersal mechanisms, such as wind or popular fruit**. The fruits of paper mulberry are highly favoured by monkeys and hornbills, maybe more so than many native species that would otherwise form their diet. For example, paper mulberry fruit can make up about 20% of the diet of chimps around Sonso in Budongo Forest (Bakuneeta, pers. comm. 1994), and the seeds found in chimp dung are viable (Plumptre et al., 1994). Since chimps have large home ranges, they may disperse the seeds widely. Hornbills, too, may travel miles between feeding and roosting sites. **An invasive exotic may therefore increase exponentially**, but by the time we notice that it has become well and truly established it may be too late to do anything about it.
- **They can often reproduce vegetatively, for instance by suckering**. Even if paper mulberry is cut down, it soon regenerates from suckers. These suckers can gradually extend through the forest from a parent tree, and will be there ready to grow if a gap should appear.
- **They often have generalised pollination systems not dependent on specific pollinators**. Paper mulberry has flowers that are attractive to a wide range of insects, so its pollination is not dependent on the presence of one pollinator. If it had a specific pollinator, the chances are that it would not set seed outside the normal range of that pollinator, unless the pollinator had also been introduced.
- **They often have a competitive advantage due to lack of specific pests or diseases**. This is one of the main reasons that invasive exotics can perform better in their new homes than in their native areas. The growth of most species of plants (and animals) is often suppressed by other pests or diseases, for example viruses, fungi or herbivorous insects. When a plant is introduced outside its natural range, normally these pests and diseases are left behind. Thus they can grow unchecked in their new home, unlike the native plants around them. Sometimes, this advantage is short-lived if the pest eventually manages to arrive as well, as in the case of leucaena and its psyllid or cypress and its aphid. So far, it seems that nothing has come along to suppress the growth of paper mulberry.

**Box 8.3**
**Four strategies for sustainable plantation forestry (ITTO, 1993)**

- **Plantations of pioneer species**, which do not displace important ecosystems or rich agricultural land, for national industrial timber requirements and possible export.
- **Planting of multi-purpose and/or nitrogen-fixing species**, as an integral part of rural development and incorporated into land use strategy at village level, where the villager controls what, where and how planting is done.
- **Planting to augment farming systems**, to add diversity, increase robustness and multiply benefits which flow from more complex systems.
- **Planting to harness environmental services**, to reduce erosion or rehabilitate waste ground.

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