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'ORPHAN TREES OF THE FOREST': WHY DO NTUMU FARMERS OF SOUTHERN CAMEROON PROTECT TREES IN THEIR SWIDDEN FIELDS?

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ABSTRACT.—Many traditional tropical-forest swidden farmers protect trees during field clearing, but the motivations for this widespread practice have been little studied. I examined this question in a study of Ntumu swidden farmers in southern Cameroon. Remnant trees have a wide range of direct uses, but they also appear to be part of a conscious strategy of agroecosystem management at different scales of space and time. These 'orphan trees' are also integrated into the Ntumu thought system, as is shown by the richness of symbolism associated with them. To test the common presumption that trees are left in fields because farmers lack time, energy or tools to cut them, we studied the impact of introduction of the chain saw in this traditional system. In this stable society, introduction of this modern tool did not affect density of spared trees in fields. Finally, I discuss the long-term impact on the African rainforest landscape of selective sparing of certain tree species, and how the practice of sparing trees may be affected by socioeconomic change.

Key words: swidden horticulture, agroecosystem management, chain saw, social representation, remnant trees, fallow

RESUMO—Em todas as florestas tropicais, certos cultivadores itinerantes deixam de cortar algumas árvores em seus campos de cultura. Mas esse hábito, embora muito corrente, tem sido pouco estudado até aqui, e os motivos que levam esses camponeses a poupar um certo número de árvores ainda não foram bem compreendidos. Analiso aqui esse costume praticado pelos Ntumus do sul da República dos Camarões. As ávores por eles poupadas prestam-se a vários usos na vida quotidiana e, acima de tudo, fazem parte integrante de estratégias para a gestão do sistema agrário, em diferentes escalas de espaço e de tempo. Além disso, essas "árvores órfãs" integram-se ao modo de pensar dos Ntumus, como o prova a riqueza simbólica que a elas está associada. A fim de pôr à prova a idéia preconcebida segundo a qual tais árvores são poupadas por falta de tempo ou de meios de produção (carburante, ferramentas, máquinas), fiz um estudo sobre o impacto causado pela introdução da moto-serra nesse sistema tradicional. Numa sociedade que ainda se acha preservada, a introdução dessa máquina moderna não perturba a densidade das árvores mantidas nos campos. Examino enfim o impacto, a longo prazo, do corte seletivo nas florestas da África central, e tento também avaliar em que medida essa prática tradicional poderia ressentir-se em razão das mudanças sociais e econômicas.

RÉSUMÉ.—Dans toutes les forêts tropicales certains cultivateurs itinérants épargnent des arbres au cours de l'abattage de leurs champs vivriers. Cette pratique très répandue demeure cependant très peu étudiée et les motivations des paysans à laisser des arbres dans leurs champs sont encore peu comprises. Ici j'étudierai cette pratique chez les Ntumu du sud du Cameroun. Les arbres épargnés font l'objet de divers usages dans la vie quotidienne et surtout ils entrent dans la composition des stratégies de gestion de l'agrosystème et ce à différentes échelles d'espace et de temps. Ces "arbres orphelins" sont également intégrés au système de pensée des Ntumu comme en témoigne la richesse symbolique qui leur est associée. Pour tester l'idée préconçue qui prétend que ces arbres sont épargnés à cause du manque de temps ou de moyens (carburant, outils, machines), j'ai étudié l'impact de l'introduction de la tronçonneuse dans ce système traditionnel. Dans une société encore préservée, l'introduction de cette machine moderne n'affecte pas la densité des arbres laissés dans les champs. Enfin, je discute l'impact à long terme de l'abattage sélectif sur le paysage forestier d'Afrique Centrale et également dans quelle mesure cette pratique traditionnelle pourrait être affectée par le changement social et économique.

INTRODUCTION

The most widespread agricultural system in the tropics is slash-and-burn shifting cultivation or swidden cultivation (Conklin 1957; Bahuchet and De Maret 1993). This type of farming is often associated with a diversity of other subsistence activities, such as hunting, trapping, fishing, and gathering for food, medicines, and materials for tools and many other manufactured items. This kind of diversified subsistence system, termed "horticulture" (Johnson 1983), is typical of farmers in the African rainforest. Adapted to low population density for subsistence production (Boserup 1965), traditional swidden cultivation is today recognized as an ecologically sustainable system (Conklin 1957; Geertz 1963; Sanchez 1976; Kang et al. 1984; Beets 1990; Whitmore 1990). Swidden cultivators use the land by creating an equilibrium between forest dynamics and crop cultivation in order to sustain food production over the long term (Gliessman 1985). Using knowledge gained by long experience, farmers manage forest regeneration to restore soil fertility between cycles of cultivation. This practice is based on the understanding that cutting and burning of vegetation adds nutrients to the soil (Benneh 1972).

Traditional swidden farming systems include many practices to enhance crop production as well as forest regeneration. Sparing remnant trees in the fields is an ancient and common practice in Central and West Africa (Bahuchet and De Maret 1993; Dounias 1993; De Wachter 1997; Rösler 1997; Sirois et al. 1998; Carrière 1999) and in Southeast Asia (Conklin 1957; Dove 1985; Ellen 1996, 1998), but is not often found in some Amazonian swidden agricultural systems, for example in French Guyana (Grenand and Haxaire 1977; Grenand 1979). Farmers often consider remnant trees in fields valuable for social reasons. Spared trees often belong to species with special cultural significance (Conklin 1957; Fosbrooke 1974; Denevan et al. 1984; Dove 1985; De Rouw 1991; Dounias 1993; Ellen 1998; Sirois et al. 1998; Carrière 1999), but the reason why traditional farmers leave trees in such systems has been little studied. Moreover, remnant trees contribute to forest regeneration in the fallows (Carrière 1999; Carrière et al. 2002a) by providing favorable conditions (nutrients and moisture) for the establishment of forest species (Buschbacher et al. 1988; Nepstad et al. 1991; Belsky and Canham 1994; Viera et al. 1994; Sirois et al. 1998) and by attracting seed dispersers, increasing the seed rain and thereby increasing the rate of regeneration under the crowns of such trees (Wegner and Merriam 1979; McDonnell and Stiles 1983; Guevara et al. 1986; McClanahan and Wolfe 1987; Janzen 1988; Guevara et al. 1992; McClanahan and Wolfe 1993; Viera et al. 1994; Cardoso Da Silva et al. 1996; Nepstad et al. 1996; Carrière 1999; Carrière et al. 2002b).

While the practice of protecting selected trees in cleared fields has often been observed in Central Africa and many other parts of the tropical world, very few studies attempt to explain it. Many authors have considered the practice to be the result of laziness or simply the lack of technical means (or of sufficient labor force) to deal with large trees, which often possess very hard wood (for studies criticizing this common notion see Dove 1985; De Rouw 1991; Dounias 1993; De Wachter 1997; Rösler 1997; Ellen 1998). However, plants may be preserved deliberately as well as by default, and many techniques are reported which involve varying degrees of protection of otherwise wild species (Dove 1985; Rambo 1985: 71; Ellen 1994:205–206; Carrière 1999). A considerable number of individual trees are spared during field clearing, and many species are represented. It is possible that, for as long as swidden cultivation has existed in Central African forests, some tree species have been spared and therefore favored in this area.

The indigenous classification of biological communities and folk systematics has received more attention than has indigenous ecological knowledge of forest dynamics. The goal of this study is to contribute to an understanding of how and why farmers leave some 'orphan trees'—as they are called by the Ntumu of southern Cameroon—in newly cleared fields. I examine to what extent this ancestral practice is the reflection of a real understanding of forest dynamics by native farmers, leading to greater adaptation of agricultural practices to a rainforest environment. Finally I will describe and interpret the social representations of remnant trees in fields in this group of traditional slash-and-burn horticulturists.

THE NTUMU REGION

The Ntumu speakers occupy the north bank of the Ntem river in southwestern Cameroon, and adjacent areas of northern Gabon and Equatorial Guinea (Figure 1). They belong to the Beti-Fang linguistic group (Guthrie 1948). The village of Nkongmeyos (2°27'N, 10°27'E), with about 245 inhabitants, is located on a plateau about 500 m asl, at the margin of the Ntem Valley (Anonymous 1990). The mean annual temperature is about 25°C and the site receives approximately 1497 mm of rainfall annually (data for Nyabessan (2°24'N, 10°24'E) 1976–1980) (Anonymous 1990). Seasonality is of the equatorial type, with two rainy seasons and two dry seasons (short rainy season from March to June, long dry season from June to August, long rainy season from September to December and short dry season from December to March). This alternation of the two rainy seasons is typical of equatorial regions. Although Nkongmeyos is north of the equator, the long dry season there occurs during the period usually characterized by a short dry season over most of southern Cameroon, and the short dry season occurs during the usual long dry season. This peculiarity is due to the orographical conditions of the region and the overall orientation of the Ntem Valley (Suchel

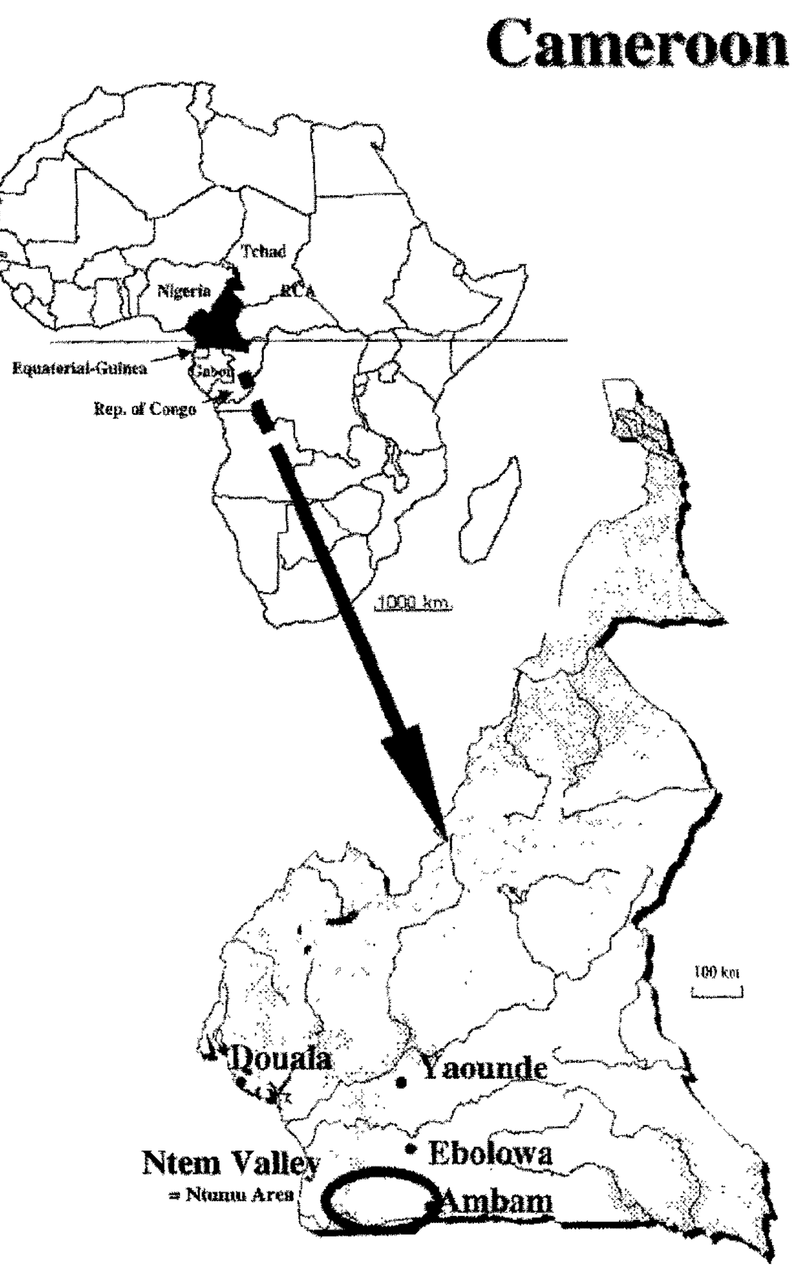

FIGURE 1.—Location in southern Cameroon of the Ntem valley and the Ntumu village in which the study was carried out.

1972). The surface geology is dominated by sedimentary and metamorphic rocks (Letouzey 1985). The hydrographic network is very dense, mainly composed of the four main branches of the Ntem, which run from east to west and are joined by many small tributaries, the flow of which varies considerably according to the seasons.

Three types of soils predominate: (1) yellow ferralitic soils originating from metamorphic rocks, (2) orthic ferralitic soils and (3) hydromorphic soils. All these soils are acid and poor in nutrients (Letouzey 1985). Predominant original vegetation is classified as transitional between semi-deciduous forest of areas to the north and the evergreen Congolean rain forest found to the south and east (Letouzey 1985), with many tree species typical of old secondary forests (no agricultural disturbance for over a century), such as *Ceiba pentandra* Gaertn. (Bombacaceae), *Terminalia superba* Engl. and Diels (Combretaceae), *Pycnanthus angolensis* (Welw.) Exell (Myristicaceae), *Triplochiton scleroxylon* K. Schum. (Sterculiaceae), *Lophira alata* Banks ex. Gaertn. (Ochnaceae), *Canarium schweinfurthii* Engl. (Burseraceae), many species of *Macaranga* (Euphorbiaceae), and *Petersianthus macrocarpus* (P. Beauv.) Liben (Lecythidaceae) (Letouzey 1985). Young secondary forests are dominated by a few abundant pioneer species such as *Musanga cecropioides* R. Br. (Moraceae), *Trema guineensis* Schum. and Thonn. (Ulmaceae), *Alchornea floribunda* Müll. Arg. (Euphorbiaceae), and many species of large herbaceous monocots (Zingiberaceae, Marantaceae and Commelinaceae) which compose the dense undergrowth of secondary forests. The whole area is surrounded by old secondary forest, and many patches of this kind of forest are found throughout the village's territory (Carrière 1999).

Apart from the practice of traditional agriculture, the area described is characterized by little human disturbance. There is no logging and no conservation-management or development projects. Population density is low, about 7 inhabitants/km^2 (Carrière 1999). However, small populations of hunter-gatherers and traditional swidden horticulturalists have lived in the area for about 2000 years. Beginning with German colonization in southern Cameroon, permanent villages have been established increasingly along the roads (Bahuchet and De Maret 1993), and consequently areas allocated to agriculture are also located on either side of the road. Ancient cultivation by humans in the Ntem Valley, as well as in many other parts of the Central African forests, has had a large influence on vegetation composition, by increasing the percentage of some secondary-forest species (Letouzey 1985).

FARMING SYSTEM

In southern Cameroon, each human population has its own characteristic field composition and crop sequence, and thus its own particular land-use cycle (Bahuchet and De Maret 1993). After field (***afup*** 'field') clearing, Ntumu cultivators use two kinds of rotation, which differ solely in the presence or absence of a first crop of *Cucumeropsis mannii* Naud. (Cucurbitaceae). In the first type of rotation, after preparing a field of about one hectare from primary or secondary forest (15 years old or more), *C. mannii* (***afup ngwan*** 'field of *C. mannii*') is planted. The vines of this crop, cultivated for its seeds that are used to prepare sauces and cakes, climb on dead burnt trunks in the fields for one season. After harvest of ***afup ngwan***, about 0.3 ha of the field is re-cleared and sown with peanuts (***afup owono*** 'field'; 'peanuts': *Arachis hypogea* L., Papilionaceae), just before the start of one of the two annual rainy seasons. Thus, three to four ***afup owono*** could be prepared from an ***afup ngwan***. In other words, one hectare of cleared land will lead to the production of four seasons of peanuts. This is a good example of the capacity of swidden agriculture to maximize the profitability of labor input (Beets 1990). Moreover, maize, onions, tomatoes, sweet potatoes, plantain, cassava, and many other crops may all be planted among the peanuts. After the peanut harvest, staple crops such as cassava, yams, taro, plantain and sweet potatoes begin growing and can be harvested after six months. The amount of time spent weeding decreases dramatically after peanuts have harvested and secondary vegetation begins to take over. The old field is termed ***kunu***, meaning literally "old field", and its distinguishing characteristic is the temporary coexistence of secondary regrowth and cultivated plants. After a time, when farmers have to search to find food in the overgrown field, it becomes a young fallow field (***enfefeng ekolok*** 'young'; 'secondary regrowth'). Ntumu farmers do not wait for production to decrease before "abandoning" a field; rather they anticipate this decrease and move prior to it, because they know that the necessary period of fallow increases with the intensity of land use. The minimum length of a fallow period in this area is about 15 years.

The second type of crop succession is similar, but lacks the ***afup ngwan*** first crop; it is created in relatively young secondary vegetation (about 15 years). In some cases, the planned future of a cultivated field is not a regenerating fallow, but a cocoa plantation for which large trees provide shade. Cocoa is the main cash crop of the region. In fields destined to become cocoa agroforest some initial practices are different. For example, during clearing a larger number of trees are left standing as shade trees for the cocoa and to increase the density of useful trees in the cash-crop agroforestry system.

Division of labor between the sexes in such Beti societies (Laburthe-Tolra 1981) results in the divergence of interests between Ntumu men and women with regard to how fields are cleared. The final result—which trees are felled and which are spared—is thus a sort of compromise. The components of the crop succession differ in their relevance to men and women. Because men's crops and women's crops differ in their needs for shade, there is a gender conflict regarding how fields are cleared. It has arisen largely as a result of the recent introduction of peanuts into the forest region of central Africa. Men's crops, especially plantain, require a lot of shade; requirements of *C. mannii* for shade are less. Women's crops, especially peanuts, do best with little shade. The way in which trees are cut or spared during field clearing must satisfy both men and women (Carrière 1999). This plantain/peanuts compromise must take into account the agroecological requirements of many other crops as well. After initial clearing, which is done by men, women approve or disapprove of the selection strategy. In general, men adjust the cutting if their women are not satisfied, because if his wife's field is not productive, a man loses respect (Carrière 1999). Despite the shared activity of agricultural production between men and women the final recognition goes to the owners of the field, that is to say, the men.

PRELIMINARY DEFINITIONS

Before discussing selective cutting as a traditional practice, it is important to define concepts and explain terminology. We define a 'practice' as a customary action, appropriate to individuals and groups. The term 'traditional' implies that these practices have been culturally transmitted over many generations, learned in diverse ways by each new generation. A traditional practice is thus a social phenomenon, and like techniques in general, may vary from one culture to another (Lemonnier 1992). 'Techniques' are here defined as "means and processes used to make tools required for the acquisition and consumption of resources" (Leroi-Gourhan 1945). According to Mauss (Mauss 1935 cited by Lemonnier 1992), in his paper on body techniques, a technique is defined as "an action which is effective and traditional [and in this, according Lemonnier, it is no different from a magical, religious, or symbolic action] felt by the [actor to be] mechanical, physical or physico-chemical . . . and . . . pursued with this aim in view." For Lemonnier (1992), any technique has five related components: matter, energy, objects, gesture and specific knowledge. I will devote most attention here to the last component, which is defined by Lemonnier as follows:

> "the specific knowledge may be expressed or not by the actors, and may be conscious or unconscious. This specific technological knowledge is made up of 'know-how', or manual skills. The specific knowledge is the end result of all the perceived possibilities and the choices, made on an individual or a societal level, which have shaped that technological action. I call those possibilities and choices social representations. Some examples of social representations which shape a technology or technological action are: the choice to use or not use certain available materials and the choice of how the action itself is to be performed . . ." (Lemonnier 1992:6)

Selective cutting of trees during field clearing is a 'traditional' Ntumu agricultural practice. By the definition of Leroi-Gourhan (1945), selective cutting does not in itself constitute a human agricultural technology, but only a part of a technological process involved in agriculture and food crop production. Remnant trees in fields are used in many different subsistence production activities. Because the fleshy fruits of some species (along with many other traits) attract animals, remnant trees enhance the value of fields and fallows as hunting sites and could contribute to "garden hunting" as seen in the American tropics (Linares 1976). Remnant trees of some species provide edible fruits, poisons used in fishing, and other gathered products. Remnant trees may also have an important agroecological function, such as providing moisture, enhancing soil fertility or accelerating forest regeneration (Carrière 1999; Carrière et al. 2002a). If we accept Mauss's (Mauss 1935; Lemonnier 1992) definition, leaving remnant trees in fields can be described as a technique because trees are spared with several aims in view, for example, soil fertilization (a physico-chemical effect) by falling fruits, leaves and flowers. The human action is the effective deliberate action of selective cutting. Remnant trees exert effects of which people are aware and which are conscious aims of management. A number of other aims are expressed by farmers for the act of leaving some trees in the fields, such as protecting soil against erosion, protecting crops against strong winds and providing shade for crops and humans and soil moisture for crops. The act of leaving remnant trees cannot be separated from other, positive actions that achieve a good balance between felled trees and spared trees and produce the desired effects on field crop production mentioned above. Techniques and particular tools exist to clear the undergrowth, to fell small trees and to prepare the cutting of large trees in such a way that they do not damage trees selected to remain.

To summarize, remnant trees in fields are an integral part of the whole process of agricultural production. Like soil preparation, plant and soil protection (Leroi-Gourhan 1945), and preparation of poisons for fishing and baits for hunting, the act of leaving remnant trees can be counted among the techniques of resource acquisition.

METHODOLOGY: SURVEYING REMNANT TREES

An 18-month investigation of swidden agriculture was conducted in Nkongmeyos village. During fieldwork, a total inventory of remnant trees was conducted in 21 fields totaling 10.38 ha. This constituted half of the active fields in this village for a given season. The inventory was composed of eight ***afup ngwan*** and 13 peanut fields (***afup owono***), seven of which were directly successional ***afup ngwan*** and six of which had been directly planted after removal of secondary forest. For each of these fields the following parameters were noted: the means used to clear it (axes and/or chain saw), the age of the forest that was cleared, and the surface area of the field. All trees found in the fields were included in the study; they were identified to species (when possible), their height and position in the field (edge or central position) were recorded, and the hardness of wood (hard, medium-hard, soft) was noted during my observations of tree felling which were then confirmed for most species by tropical forestry guide book (CTFT 1976). Interviews with villagers and observations of farmer activities in fields and fallows were conducted to understand why they retained some trees in the fields. For the dependent variables, Kruskal-Wallis one-way non-parametric analysis of variance (SAS 1996) was used to compare means and to test effects on the tree density variables. Student's t-tests were done to compare means two by two.

PROTECTED TREES IN THE FIELDS: HOW MANY AND WHICH ONES?

A total of 355 trees, belonging to at least 67 species and 27 families, were found in the 21 sampled fields (Appendix 1). Of the trees sampled, 54 were hardwooded, 53 had medium-hard wood and 241 were soft-wooded (Appendix 1). The number of species is probably an underestimate, because several undetermined species of species-rich genera (e.g., *Ficus*, Moraceae) were not included. The distribution of individual trees according to position in the field (peripheral or center) and among height classes is shown in Table 1. The three most frequent species in the sample (*Ceiba pentandra*, *Triplochiton scleroxylon*, and *Terminalia superba*), all soft-wooded, together accounted for about one-third of all trees. Nine other species, accounting for about one-third of the total number of trees, were each represented by at least 10 individuals. The remaining one-third of the total number of trees were represented by 55 species, each of which was represented by fewer than 10 individuals (Figure 2).

Ntumu traditions include many examples of protective behavior towards

TABLE 1.—Total number of individual trees sampled in the 21 fields (10.38 ha) classified according to position in the field and to height classes (m).

	Position in the field		Height (m)		
	Peripheral	Center	≥30	30 > x > 15	≤15
n individual trees	185	167	231	101	20
Totals	352			352	

trees, but in many cases socioeconomic and ecological considerations may influence decisions to spare or not to spare trees in fields. Labor availability for felling is perhaps an important factor influencing the number and the type of trees left in fields. An old or very young person or a widow with only young children may not be able to clear undesirable medium-sized or large trees, or such individuals may select sites with only small, soft-wooded trees which will thus contain few remnant trees after clearing. Lack of time or money may also influence decisions about field choice and field clearing.

Field management practices are also constrained by weather conditions. A good swidden burn depends on timing the clearing so that slashed vegetation is dry before the arrival of the first rains of the wet season. Too much moisture in the slashed vegetation will reduce efficiency of the burn and result in decreased productivity. Thus, if rains arrive earlier than predicted, a farmer may have to burn before all undesired trees can be felled, in order to have an adequate burn before continued rains make burning completely impossible. In this situation

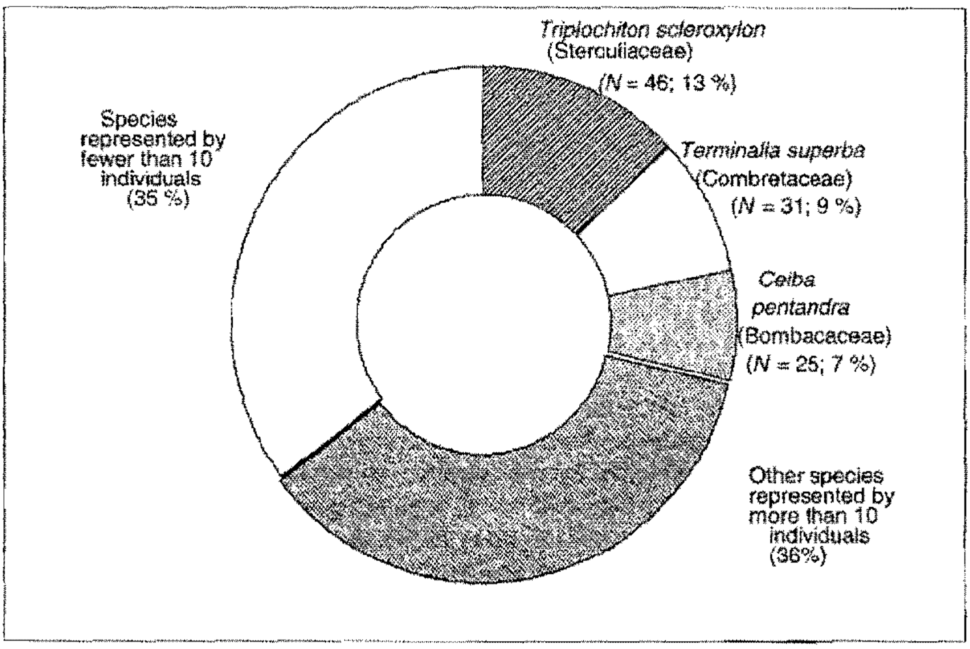

FIGURE 2.—Species composition of the trees protected in swidden fields by Ntumu farmers.

Orphan tree categories :
according to desirability and socioeconomic constraints

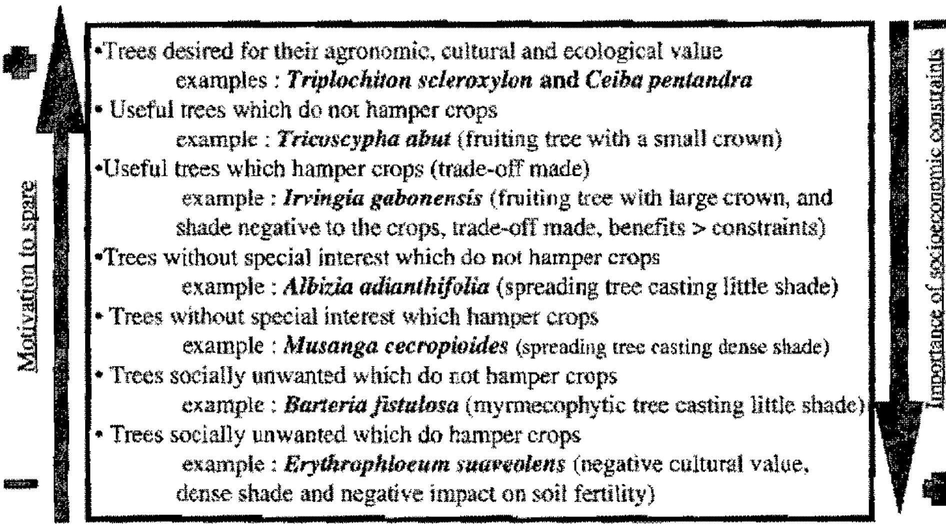

FIGURE 3.—Categories of "orphan" spared trees, according to Ntumu farmers, based on their desirability and on socio-economic constraints that affect clearing of the fields. The greater the desirability of the tree, the less other socio-economic factors intervene in felling decisions.

more trees are observed to be left in the fields. This could have an important impact on the crops, but in the farmer's judgment, an adequate burn is more important than the cutting of all undesired trees. The inverse situation can arise if the rains arrive even earlier, before a field has been cut and has had time to dry. The farmer may abandon the field and borrow another parcel from a relative. In many other situations where labor (or money to pay for labor) is lacking, Ntumu farmers must make compromise decisions regarding cutting of trees.

Figure 3 classifies different species represented among orphan trees according to the type and degree of incentive to spare (or cut) the tree, and the influence of socioeconomic constraints. In some cases, people must weigh the benefits (e.g., fruit or wood production) against the disadvantages (e.g., dense shade or cultural undesirability) associated with a particular tree. Some parts of the field are suitable for crop cultivation, whereas other parts may be principally useful in providing fruits, firewood, and other non-crop products. Figure 3 suggests that the more desirable the tree, the stronger the socioeconomic disadvantages must be to modify the decision to spare it. Conversely, the less a tree is desired, the stronger the socioeconomic disadvantages must be to modify a decision to cut it. Sometimes, the decision to cut or not to cut is based on other criteria. Some species are left standing because they interfere with crop cultivation when felled. For example, some much-branched large trees are very difficult to cut apart after felling. The bulky fallen crowns hamper cultivation by creating areas difficult to penetrate; difficult to weed, uncleared areas quickly become impenetrable and choked with vines. Such trees may be killed by girdling and/or burning, to provoke the rapid fall of leaves and thus prevent them from casting too much shade. In this way, some unwanted species (e.g., *Pachypodanthium barteri* (Benth.) Hutch. and Dalz., Annonaceae) are eliminated without damage to the crop.

Many fields are established in old secondary forest. Here, clearing is easier because there are few large trees. These are mostly those spared in previous cultivation cycles and thus likely to be spared again.

WHY DO NTUMU FARMERS PRACTICE SELECTIVE CUTTING?

Selective cutting enhances fertility. In addition, some trees are more useful than others. Finally, trees are metaphors for people and so are part of the social world.

Management of Environmental Fertility on a Spatial Scale.—Some species of large trees, such as *Ceiba pentandra* (Bombacaceae), *Terminalia superba* (Combretaceae), *Triplochiton scleroxylon* (Sterculiaceae), *Chlorophora excelsa* (Welw.) Exell (Moraceae), are considered to be indicators of fertile soils. They are used by Ntumu farmers to guide the selection of a site for a future field. Individuals of these species are always present in the fields because of their high relative abundance in this area. The presence of some of these species could be more important than direct observation or perception of soil composition and structure in determining choice of site for a new field. Men and women think that falling leaves, flowers, fruits and animal excretions increase soil fertility beneath trees of these species in the fields, as well as in the forest. Ntumu farmers have noticed that soil fertility is quite heterogeneous in the forest and that this heterogeneity remains and may be even augmented after burning, because of the irregular distribution of ashes and trunks in the field (Nye and Greenland 1964). Leaving some standing trees in fields contributes to the management of soil fertility. Soil texture and color, or other readily evident soil traits, are in this environment not reliable indicators of fertility. The kind of trees growing on a site may be the most reliable indicators of potential fertility, both because certain trees grow on relatively favorable sites and because they create good sites by addition of litter. The practice of tree selection indicates how people could have adapted to a variable and unpredictable environment based on a deep knowledge of local ecology and soil potential (Allan 1972:217).

As is indicated by Ntumu technical vocabulary, the proper mix of light and shade is very important for field management. Very few adjectives are employed to designate different qualities of soils, but many nouns and adjectives designate the quality and quantity of light and shade (S. M. Carrière, unpublished data). Trees selected to remain in the fields must provide good shade (diffuse shade, but not too dense) for crops. Large, tall trees with high crowns casting diffuse shade that moves over the course of the day best meet this requirement. In a treeless field, leaves of some crops (such as plantains, macabo, taro, yams, sweet potatoes, and sometimes peanuts) would suffer from overheating and wilting, which could jeopardize production. Such crops are often planted beneath orphan trees to enjoy shade and fertility advantages. Another crucial point is that women, who usually take their infants with them into fields all day, need shady places to keep them. Men and women also rest beneath orphan trees during pauses in work.

Ntumu farmers believe that shaded conditions beneath orphan trees, along with the intact root system, increase soil humidity. Also, remnant trees reduce wind velocity at ground level in fields, lessening the destruction of fragile crops such as cassava and plantain caused by the violent thunderstorms that occur during the transition between dry and rainy seasons. Thus, orphan trees contribute to the management of climatic risk. The strategy of field clearing is adopted in a way that assures an appropriate trade-off for each parameter that affects crop production, such as fertility, shade, and humidity. During tree felling, Ntumu farmers must take into account the number, position in the fields, height and shape, species, and density of the trees that are going to be spared. The position of the trees depends on the orientation of the fields and on the vegetation types and large trees located on field perimeters. The choice of site and orientation of future fields takes into account the sun's daily trajectory, which determines the position and trajectory of shade cast by each tree crown. For example, in the fields surveyed, no trees were left standing where trees bordering the field already provided shady conditions. In contrast, more tall trees were left in parts of fields where nothing else could provide good shade.

Management of Environmental Fertility on a Temporal Scale.—The crucial point in a swidden agricultural system is the management of the fallow period. Orphan trees are favored by the Ntumu because of their additional ability to facilitate regeneration of secondary regrowth. Ntumu farmers think (according to my interviews) that it is the growth of vegetation that restores potential soil fertility. In swidden agriculture the fallow period is crucial for the sustainability of the system. As did Hanunóo farmers in the Philippines (Conklin 1957), Ntumu farmers stated that the more trees in the fields, the shorter the fallow period. Selective felling seems to be an ancient practice to manage and favor forest succession in the fallows, the key point of such a system. These trees form the initial point of succession to forest (Yandji 1982; Denevan et al. 1984; Engel et al. 1984). Many studies have shown that remnant trees in pastures and fields increase seed rain beneath their crowns by attracting frugivorous animals which could disperse seeds of forest plants (Carrière et al. 2002b). Also, physical conditions beneath such trees favor growth of trees rather than herbaceous plants, thereby increasing the speed of succession (Carrière et al. 2002a). Beneath remnant trees in fallow fields, patches of regeneration could be observed, corresponding to the nucleation model of succession (Yarranton and Morrison 1974). During the fallow period remnant trees continue to fertilize the soil and contribute to establishing a good humus layer. After the fallow period the same trees will be spared during a renewed cycle of felling. This facilitates decisions about felling and ensures that the cultivators choose a parcel already tried and tested for its fertility.

The choice of species of tree left in fields depends also on other criteria of fertility management on a temporal scale. The land belongs to the first man who cleared it and this parcel will be transmitted to his children (Carrière 1999). Trees selected are thus chosen not only because of any immediate benefits which they might confer, but also because of the positive effects they have in later cycles of cultivation by the farmer's descendants. According to the Ntumu, tree species often left in fields, such as *Ceiba pentandra, Terminalia superba, Triplochiton scleroxylon,* and *Chlorophora excelsa,* also add greatly to soil fertility when they die and decompose. The slow decomposition of the tree's trunk and branches provides a large quantity of mineral and organic nutrients, and according to the Ntumu yields will be greatly increased for many years through this process. For all these reasons, the long term strategy of Ntumu cultivators favors the choice of areas where such trees are common. The presence of spared trees influences floristic composition and the structure of regrowth vegetation (Carrière et al. 2002a). The number and identity of trees spared depends on the future use of the land. Thus, the cacao agroforests of the Ntumu began as new food-crop fields in which some species were favored in order to facilitate the creation of the agroforestry system. In parcels slated to become cocoa agroforests, more trees are spared, to provide the high, less open canopy of the agroforest. All useful trees are kept alive in order to concentrate resource-providing trees in the agroforest. After food-crop cultivation, the secondary regrowth is regularly cleaned to favor young trees of desirable species and to protect and encourage growth of cacao seedlings and saplings. Sparing trees during clearing allows farmers to manage the fertility and productivity of future cacao agroforests.

Trees Useful in Contexts Other than Agriculture.—One of the most common reasons given by Ntumu farmers, as well as by many other rainforest swidden farmers, to explain why they leave remnant trees is their utility in non-agricultural aspects of the production system (Conklin 1957; Dove 1985; Posey 1985; Bahuchet and De Maret 1993; Dounias 1993; Warner 1995; Ellen 1996; Carrière 1999). As shown in Table 2, they may provide edible fruits, ornamental flowers, or plant organs to prepare medicines. Their seeds may be used to prepare sauces or to provide playing pieces for games. Other species provide latex or resin, used to light fires, and toxic sap used in fishing poisons. Some species when fruiting attract many animals and are used as favorite hunting sites. Other species are hosts for edible caterpillars. Many species supply firewood and timber and other construction materials (planks, laths, posts, mortars, pestles, dugouts, canoes . . .). All of these trees are not necessarily used during the current cycle of cultivation but represent a standing, living capital that can be used later. Remnant trees in fields and fallows constitute a continuously available reserve of wood and they can be sold to pay for unpredictable future needs, such as school supplies, health care and cash crop cultivation (seeds, fertilizer, etc.). Field management includes taking care of this capital. The orphan trees contribute to the Ntumu subsistence strategy, which is based on their cosmogony of moderate use of nature by carefully controlling access to each wild resource (Bahuchet 1997).

Unwanted Tree Species.—Some tree species are unwanted by Ntumu as orphan trees and are felled when possible. Some are attractive to pest insects. Others, such as *Barteria fistulosa* Mast. (Passifloraceae), house very aggressive ants. This tree species is usually burnt alive during the burning of the fields. Felling *Barteria* is dangerous, because people are attacked by the tree's stinging ants. If a *B. fistulosa* tree survives the fire, the tree is left standing in the field and much care is taken to avoid it. In the past, this "magical" tree was used by elders to punish unfaithful

TABLE 2.—Uses of protected tree species in the fields by the Ntumu (authorities in Appendix 1).

n	Family Species	Local name	Anatomical part	Principal use
	Anacardiaceae			
5	*Tricoscypha abut*	***amvut***	fruit, bark	food, medicine
	Apocynaceae			
1	*Rauwolfia macrophylla*	***esombo***	bark, latex, fruit	medicine
1	*Funtumia elastica*	***ndama afan***	leaves, resin	resin, latex
	Bigoniaceae			
1	*Spathodea campanulata*	***evovon***	flowers	ornamental, medicine
	Bombacaeae			
25	*Ceiba pentandra*	***dum***	wood	firewood, construction
	Burseraceae			
6	*Canarium schweinfurthii*	***otou***	fruit, seed, latex	food, game, fire resin
1	*Dacryodes edulis*	***asa***	fruit	food
	Combretaceae			
31	*Terminalia superba*	***akom***	leaves, wood	edible caterpillars, firewood, construction
	Euphorbiaceae			
1	*Ricinodendron heudelotii*	***ezang***	seed	sauce
4	*Macaranga* sp.	***assas***	wood	firewood, construction
	Irvingiaceae			
19	*Irvingia gabonensis*	***andok afan***	fruit, seed	food, sauce
3	*Desbordesia glaucescens*	***alep***	bark, leaves	medicine
	Loganiaceae			
4	*Anthocleista schweinfurthii*	***elolom***	leaves, fruit	medicine
	Mimosaceae			
1	*Tetrapleura tetraptera*	***akpwaa***	fruit, seed	food, sauce
3	*Penthaclethra macrophylla*	***abe***	fruit	sauce
15	*Albizia adianthifolia*	***sayema***	leaves, bark, fruit	medicine
	Moraceae			
5	*Myrianthus arboreus*	***engokom***	fruit, crown	food, hunting site
15	*Musanga cecropioides*	***asseng***	fruit, wood	food, hunting site, firewood, construction
16	*Chlorophora excelsa*	***abang***	leaves, bark, wood	medicine, clothes,[1] firewood, construction

TABLE 2.—(continued)

n	Family Species	Local name	Anatomical part	Principal use
10	*Ficus* sp.	—	fruit, latex, bark, crown	food, medicine, clothes, hunting site
	Myristicaceae			
15	*Pycnanthus angolensis*	***eteng***	fruit, crown	hunting site, medicine
	Papilionaceae			
11	*Pterocarpus soyauxii*	***mbee***	bark, leaves, wood	medicine, firewood, construction
	Rutaceae			
3	*Zanthoxylum macrophyllum*	***olon***	bark, fruit, leaves	medicine, fishing poison
	Sterculiaceae			
13	*Eribroma oblongum*	***ndjong***	crown, bark, fruit, wood	hunting site, medicine, firewood
46	*Triplochiton scleroxylon*	***ayos***	leaves, wood	edible caterpillars, firewood, construction

[1] During historic times before "modern" cloth became widely available.

wives and thereby discourage subsequent offences. Women were attached naked to the tree for a night during which they were repeatedly stung.

Another tree, *Erythrophleum suaveolens* A. Chev. (Caesalpiniaceae), is undesirable because of its reputed capacity to sterilize the soil. The leaves and sap of this tree contain poisonous alkaloids and other substances which could have allelopathic effects on cultivated crops. Nevertheless, for several reasons this tree species is often observed in fields, where it usually occurs along the edge, to limit its impact (Appendix 1). This species was also used in the past as the 'truth tree'. Its powdered bark was inhaled by the accused person, whose reaction (no reaction or sneezing) determined the verdict. Even today, some people hesitate to cut it for fear of reprisals. A second reason this tree is often left standing is that its very hard wood prevents felling using axes, except by strong, young but experienced men. To face the different constraints of this species, Ntumu have created a rule. Before crop cultivation a present is made to the *E. suaveolens* tree (***aféé elon***: ***aféé*** 'present'; ***elon*** '*E. suaveolens*'), consisting of a few crops planted beneath these trees for a while. If the tree accepts the present, the crop will produce and the farmer can continue to establish the real plantation. If the present is not accepted, the farmer must go elsewhere to find a new site for his field.

Other species, such as *Pachypodanthium barteri* (which casts dense shade), are unwanted because they are known to discourage growth of crops.

Social Considerations.—Remnant trees in fields are termed ***ntolonboh' élé afup*** ('orphan'; 'tree'; 'field': 'orphan trees in the fields'), by the Ntumu because they have been left alone, having lost all of their fellows during field clearing. The cutting of large trees, done by men only, is compared to a heroic, painful and dangerous warlike activity. "When a man is cutting the forest, he is engaged in warfare," as Laburthe-Tolra (1981) puts it for the Beti. Field clearing is considered the highest-risk activity of shifting cultivators (Conklin 1957; Dounias 1993; Carrière 1999). Among the Ntumu, the same sexual and behavioral prohibitions applied to hunting and war activities are also applied to the cutting of large trees (with axes or by chain saw). During the 'war-like act' of field clearing, some survivors are left standing in the fields. These become the orphans of the forest. As with orphan people in Ntumu society, orphan trees have a special social duty in recreating life. Among the Ntumu, orphaned people leave the familial house and build their own village. In Beti society some new lineages were created in this way (Laburthe-Tolra 1981), consistent with the value placed by the Beti on conquest of forest land and an out-migration strategy. Similarly, orphan trees in the fields are seen as contributors to forest regeneration and lose their orphan status when new trees grow to join them during the fallow period. The symbolic war between humans and forest has a double meaning. The first is to clear the forest and to win against the forest in order to achieve an action of which one can be proud. The second is to let the forest win the reconquest of the land and accept the lost battle. The respect of this kind of pact allows the farmer to return to the fallows to cultivate another time. In contrast, the intensification of cultivation can lead to the total destruction of soil potential. According to Dounias's analysis, humans have to reach a pact with the forest and accept the constraints of access (Dounias 1993).

Never, during 18 months of field work, did I observe fields cleared by Ntumu farmers that lacked remnant trees. Indeed, to the question, "Can you conceive of cutting all the trees during the clearing of the forest?" the Ntumu farmers answered, "never, it is an impossibility." Through this categorical answer, we perceive the crucial importance of this practice. As is often mentioned, many techniques and conceptions are learned without any masters or apprentices (Colleyn 1988). However, the strategy of felling is extremely complex and dangerous, and young farmers need to learn how to cut the trees and how to avoid the destruction of others. This training can take many years of working with an experienced person, such as a man's father. In fact, for several reasons that we develop below, Ntumu men and women choose their future fields based on the presence of some species of trees, which will be spared during field clearing. After choosing the field's location the cutting is planned. The farmer must take into account the positions of the crown of each tree, where the tree will fall, the presence or absence of lianas between the trees, and which trees are to be cut and which spared. Finally, he has to organize clearing so that it requires as little work as possible.

In Central Africa, native societies customarily plant trees or use existing trees to indicate boundaries and land ownership (Bahuchet and De Maret 1993). This is particularly the case with some rare species, such as *Baillonella toxisperma* Pierre (Sapotaceae) or *Guibourtia tessmannii* (Harms) Léonard (Caesalpiniaceae). In any case, all trees spared during clearing land for cultivation belong to the first cultivator. All use of these trees is reserved for the family of the owner, but trees can be sold or loaned for a period. In this case, compensation, whether monetary, a part of the harvest, or in kind, is fixed and required by the owner. Many orphan trees in fields serve to indicate property limits and remain useful when farmers come back to clear an old fallow in regrowth where limits are no longer obvious.

Trees as Social Symbols.—In order to understand why Ntumu farmers exercise a certain kind of protective behavior towards trees, it is important to examine the system of thought embedded in the culture, the symbolic representation of trees in this system, and finally the history of the society. Techniques and conceptions of the world are reflected in collective representations and grounded in a particular ideological and symbolic system. These techniques and conceptions are learned, but without formal training. Among the Ntumu, many symbolic correspondences exist between characteristics of people (such as age or gender) and characteristics of trees. We must thus examine the symbolic and religious functions of trees (Bahuchet 1997). The following examples are very indicative.

In Ntumu society, as well as in many other lineage societies of central Africa, there is no central authority. Power belongs collectively to the elders of the lineage. Thus, the system of values attributes particular value to age. To be old is to be more sacred. Old persons are respected and have extrasensory faculties. Elders are imagined to be in contact with the beyond. After their death, the respect offered old persons is transferred to an ancestor cult (Colleyn 1988). In such a society, old trees may be respected as are the old persons. During cutting and burning of the fields, almost all of the old large trees are spared. Only specifically undesirable trees are sometimes destroyed. The density of large trees in the forest is low, so clearing the forest corresponds to cutting the layers of medium and small trees. This allows much needed light for crop growth to reach ground level without cutting the old respected trees.

The bark of *Chlorophora excelsa* was used to prepare bark cloth, made and worn by men. Bark of this tree is important in the ancestral symbolism of the Beti (Laburthe-Tolra 1981), including the Ntumu. This species is a majestic, large forest tree with an erect trunk; it produces a milky white latex, symbolically associated with semen and hence fertility. The fibers of the bark were in permanent contact with the men's sexual organs in order to transmit to the people the characteristics of the trees and to receive the beneficial influence of the ancestors on sexual fertility (Laburthe-Tolra 1981).

Canarium schweinfurthii is another species of great social importance. The resin produced by this species (***otou*** '*C. schweinfurthii* resin') is used by the Ntumu to create and maintain the fire in a village household, in the fields, and in forest encampments during hunting and fishing expeditions. The symbolic aspects of this resin are very important in understanding why it is inconceivable to cut such a useful and protective tree. The soot of the resin "***otou***" is rubbed on skin scarifications in order to produce blue tattoo-like decorations. At the beginning of this century this practice was very important in Ntumu populations in the Ntem valley (Tsala 1958, 1973). These tattoos were made when boys were circumcised, to make them sexually attractive and to show the power of the owner. The tattoos were required for recognition by the boy's family, to attract the love of living humans, and to frighten malevolent beings (Laburthe-Tolra 1981). In fact the resin of this tree was burnt during rituals to produce an incense considered to be sweet to the ancestors. The resin was also used to fuel lamps during rituals. A family chief could burn the ***otou*** when troubles appeared because ***otou*** could chase out witches. Protection was required during the making of tattoos and ***otou*** incense was used to light and protect forest encampments against malevolent spirits during hunting or fishing expeditions.

Ceiba pentandra assumes the same sexual connotations as *Chlorophora excelsa,* because of its majestic erect trunk. The Ntumu local name of this species, ***dum*** (Carrière 1999), recalls glory and celebrity (***dum*** 'glory', 'celebrity') (Laburthe-Tolra 1981). The base of this tree, usually with massive buttresses, was used as a sepulcher where the dead were buried, to maintain among the ancestors the properties of the trees: glory and power. It was also mentioned by Dove (1985: 125–126) that trees with sacred value include those growing in ground in which human remains have been interred.

Finally, the case of *Triplochiton scleroxylon* is interesting because it shows the correspondence of the domain of nature and cultivation with the psychological characteristics of humans. One of the Ntumu (and Beti) local names of this tree is ***edjidjin***, which means a good and beautiful light shade that is considered to be the best shade for cultivated plants. It is due to the shape and the height of the crown of this species. This word is also used to refer to the character of a good person, especially someone calm and dignified who does not create problems for others.

THE IMPACT OF CHAIN SAWS: A CLUE THAT SPARING REMNANT TREES IS A DELIBERATE AGRICULTURAL PRACTICE

In many studies on native swidden agriculture, sparing of isolated trees is ascribed to laziness, to the lack of means for cutting very hard-wooded trees, which often possess massive buttresses, or to socioeconomic difficulties in procuring tools or labor (De Rouw 1991; Dounias 1993; De Wachter 1997; Rösler 1997). But such an interpretation may reflect the lack of studies focused on this practice and on the reasons why selective cutting is done. At present, with the recent extension of some "modern" tools such as the chain saw (De Rouw 1991; Dounias 1993; Ellen 1997; Joiris 1997) all over the tropical world, we have an opportunity to examine this question. What remains in an Ntumu field when a chain saw is available for clearing? Are the harder-wooded trees more common in the axe-cleared fields? Villagers of Nkongmeyos began to use chain saws about five years ago, though axes continue to be the most widespread tool used to clear the forest. If remnant trees are left because people lack easy means to clear them, the availability of chain saws should result in a important decrease in the number of trees left. In particular, the number of hard-wooded trees left standing should be lower. On the other hand, if our hypothesis that sparing remnant trees in the fields is a deliberate practice is correct, then the use of the chain saw should not affect the practice of selective cutting. The use of the chain saw show allow us to examine the impact of the chain saw on the number of remnant trees and among them the number of hard-wooded trees left in the fields.

Mean Density of Trees in the Fields.—In the *C. mannii* fields ***afup ngwan*** (N = 8 fields; 3 cleared by axe, 5 cleared by chain saw), the results showed that there

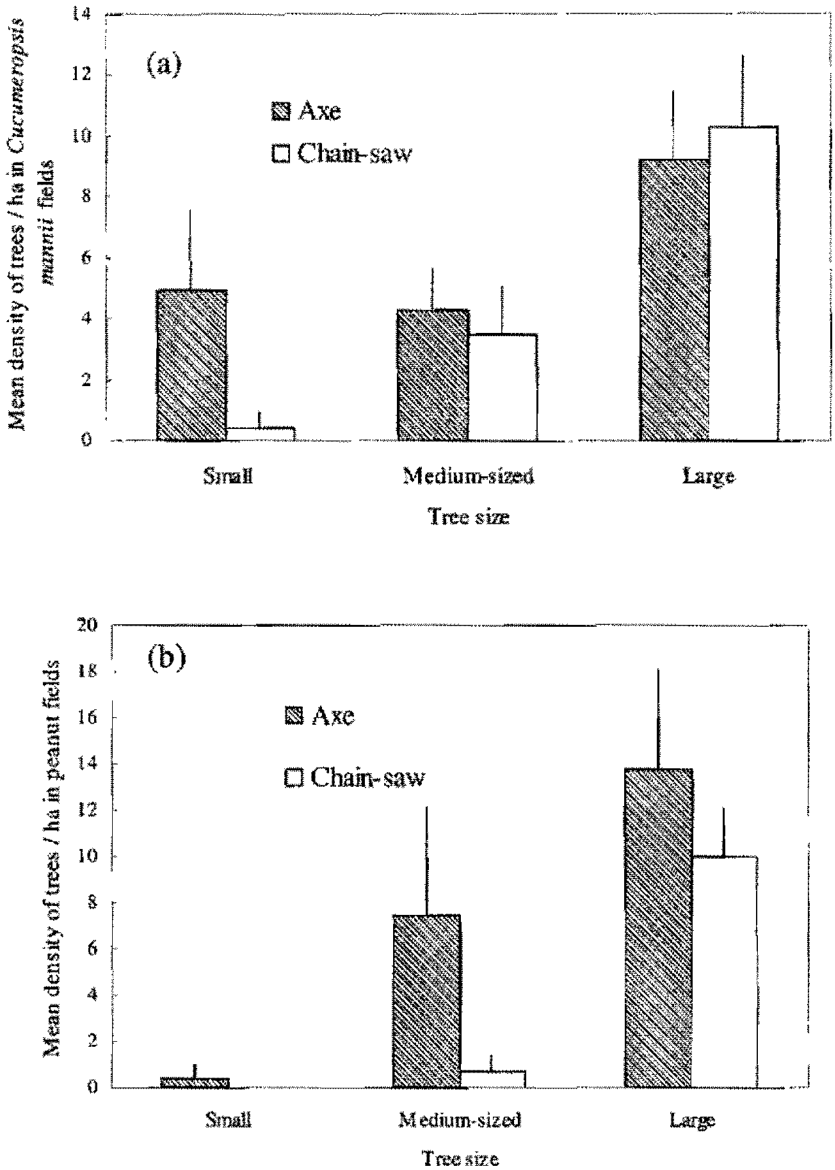

FIGURE 4.—(a) Mean density of trees/ha in *C. mannii* fields, and (b) mean density of trees/ha in peanut fields for different tree size classes depending on the method of clearing, by axe or by chain saw. Bars are standard deviations.

was not a significant difference in density of (1) large trees ($F_{1,6} = 0.23$; $P>0.05$; Figure 4a) and (2) medium-sized trees ($F_{1,6} = 0.24$; $P>0.05$; Figure 4a) between fields cleared with axes or with chain saws. Density of small trees was lower in chain saw cleared fields but this concerns only a small percentage (6%) of all trees left. Ntumu farmers say that fields are made more "clean" when a chain saw is used because when cutting is done with axes, some small intruder trees are left standing to save the time that would be lost in cutting them. Another point showed that in almost all fields cleared by chain saw, work was done by people hired from other villages or households, who find it easier to cut everything than to pay attention to each small tree. Despite small sample size that has been available, chain saws appear to have an impact on the mean density of small trees.

If we consider peanut fields (N = 13 fields; 8 cleared by axe, 5 cleared by chain saw) only, the results were quite different (Figure 4b) but this was not directly and solely the consequence of the means of clearing. For all size categories of trees, density of remaining trees was not significantly higher for both medium-sized ($F_{1,11} = 3.00$; $P > 0.05$) and large trees ($F_{1,11} = 0.78$; $P > 0.05$) when clearing was done with axes than with chain saw, but for both size classes there was a trend in this direction (Figure 4b). Though increasing the sample size would have a probability of producing a significant difference, several factors may combine to account for this trend, and for the apparent difference between peanut fields and *C. mannii* fields. First, for both kind of fields, all of the fields cleared directly from young secondary forests were cleared with axes. All of the peanut fields mentioned as "cleared by chain saw" had in fact directly succeeded a *C. mannii* field that had been created by clearing primary or mature secondary forest and cleared with a chain saw (there was not a second clearing between harvest of *C. mannii* and sowing of peanuts). *C. mannii* fields are each about 1 ha and peanut fields about 0.25 ha. Peanuts require sunlight to grow and produce well. Medium-sized trees, whose low crowns produce denser shade than the high crowns of large trees, have particularly negative effects on the peanut crop. Women could thus in this case choose an area of low tree density in the *C. mannii* harvested field to establish a peanut field. This choice introduced a bias in the estimation of tree density in the peanut fields that succeeded *C. mannii* fields. Fields of *C. mannii* remain the only ones that were cleared and cultivated in their entirety. For this reason peanut fields cleared directly from secondary forest are not directly comparable with those located in the less shaded part of *C. mannii* fields. Thus fields of *C. mannii* remain the most appropriate for comparing the impact of the chain saw on the decisions made by the farmer to keep some trees in the fields. The second point that may explain the higher density of medium-sized and large trees in my sample of axe-cleared peanut fields concerns the particular clearing conditions of two of these fields which had been cleared with an axe by widows helped by their children. The density of trees in these two fields (40 trees/ha and 36.7 trees/ha) are not representative of the whole sample of axe-cleared fields (mean density = 21.0 ± 12). The mean density of trees without these two fields is lower (mean density = 16.7 trees/ha ± 8.9).

Mean Density of Trees and Hardness of Wood.—In the fields sampled (N = 21), the results of Student's t-tests showed that for both medium-sized and large trees, no class of wood hardness showed a significant difference in density between fields cleared with an axe or with a chain saw (Figure 5). Very hard-wooded and medium-hard-wooded large tree species (such as *Lophira alata, Chlorophora excelsa, Eribroma oblungum, Desbordesia glaucescens, Erythrophloeum ivorense, Klainedoxa gabonensis,* and *Petersianthus macrocarpum*) are less important in this area than soft-wooded species because the most frequent species in the cleared forests are soft-wooded pioneer species (such as *Ceiba pentandra, Pycnanthus angolensis, Terminalia*

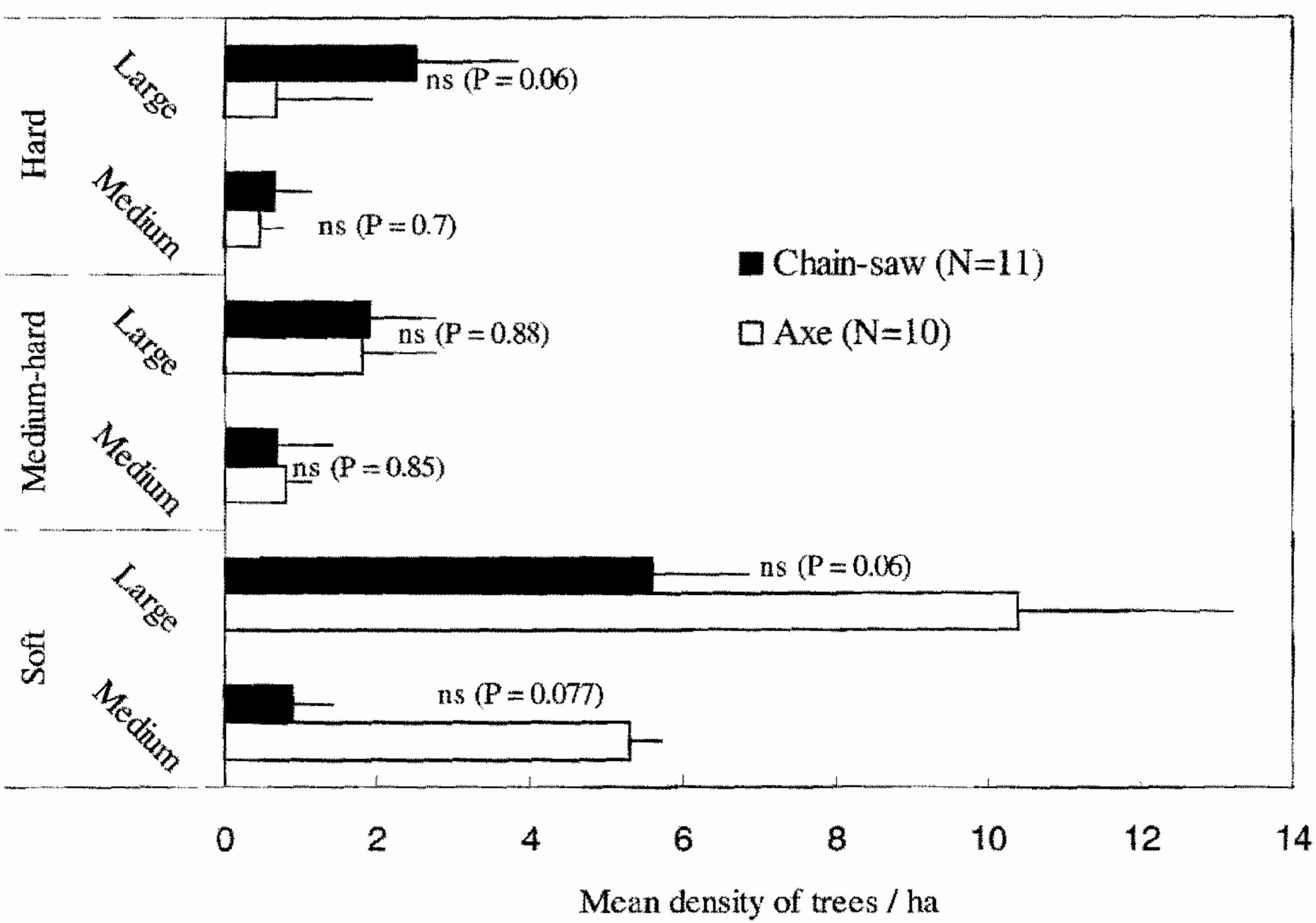

FIGURE 5.—Mean density of trees/ha in Ntumu fields for different tree size classes and wood hardness classes depending on the method of clearing, by axe or by chain saw. Bars are standard deviations.

superba, and *Triplochiton scleroxylon*). Although there was not a statistically significant difference, two tendencies can be observed for hard-wooded and soft-wooded classes. The negative impact of chain saws on the density of hard-wooded trees is not demonstrated (mean density of hard-wood was higher in fields cleared with a chain saw); but the insufficient statistical power (small sample size, large variance), and the not real absence of an effect, may explain the non-significance of results. The tendency observed could be explained, however, by the fact that most of the fields sampled that were cleared from old secondary forest (where hard-wooded species were most frequent) were cleared with a chain saw. This tendency could suggest that the chain saw could have influenced the choice of forest type to be cleared and thus have an impact on the percentage of primary forest clearing every year. With the coexistence of the two methods of clearing (axe and chain saw) it is difficult to determine whether farmers try to get a chain saw when they have to clear old secondary or mature forest, or whether they decide to clear this kind of forest when they know that a chain saw is available.

As for the mean density of trees in the peanut fields, the tendency for higher density of soft-wooded large and medium-sized trees in fields that were cleared with axes is mainly due to: (1) the atypical high density in the two fields that were axe-cleared by widows and (2) the bias introduced by the fact that women can choose some of their fields in the less shaded part of the *C. mannii* fields (see below). If we omit these two atypical fields in the statistical analysis the Student's t-tests are not significant with higher probabilities ($P = 0.2$ for Soft-Large class and $P = 0.16$ for Soft-Medium-Sized class of Figure 5).

The chain saw is seen by anthropologists to be a baneful influence partly responsible for the erosion of sustainable long standing practices and knowledge (Ellen 1997) and responsible for new types of radical clearing. In the case examined here, however, the chain saw appears to have an impact on the making of decisions about which and how many trees to keep in the fields. Chain saw clearing is often done by hired people, and they cut small trees rather than pay attention to each one as does the owner. Social relations between trees and the people cutting them have begun to change. However, even when tools, labor and money to buy fuel are available, Ntumu farmers continue to leave trees in the fields. But the availability of chain saws could also have a great influence on the type of forest chosen for clearing because it is easier to clear a primary forest with a chain saw than with an axe, and parcels cleared from primary forest are more productive, especially for the important man's crop, *C. mannii*. Although the chain saw does result in changes, even with chain saw cleared fields there are still many remnant trees. Selective cutting is an intrinsic part of the techniques used in this swidden agricultural system. This conclusion runs counter to the widespread belief, also criticized by many other authors (e.g., Condominas 1997), that swidden farmers are lazy, unsettled and environmentally ignorant. It also shows that the introduction of new powerful tools, unaccompanied by any major social and economic change, does not necessarily fundamentally alter the way people manipulate the environment. But the changes we observed suggest that the selective cutting compromise remains fragile.

CONCLUSION

Sparing remnant trees in the fields is an ancient agricultural practice in traditional Ntumu society. 'Orphan' trees allow Ntumu and probably many other populations of traditional farmers to manage the fertility and productivity of the environment in space and time. It is remarkable to see that the roots of agroforestry management practices can be found in traditional agricultural systems.

We can postulate that if the cutting compromise between needs of men's crops and those of women's crops exists, it is due to the very great diversity of crops cultivated, each with its own particular ecological needs. Equilibrium can exist only if various crops co-occur in the same fields. The cutting strategy in field clearing must satisfy the ecological conditions required by each of the crops co-occurring in space and succeeding in time. Furthermore, remnant trees contribute to facilitating forest regeneration in fallows. The practice of sparing trees reflects a good understanding of ecological processes such as maintenance of soil fertility and forest regeneration. This practical knowledge of forest ecology contributes to adaptation of agricultural practices and techniques to the rain forest environment.

Along with the physical constraints and possibilities presented by the material world, the social representation of this technology also influences the actual outcomes (Lemonnier 1992). Ethnobotanical knowledge and practice, must, therefore, be understood contextually, and recognized as intrinsically variable and subject to change (Ellen 1996). Like the Ntumu, many other populations have an important role in shaping the landscape and thereby affecting how floristic composition varies in space and time. Many people of the rain forests selectively fell trees, protecting valued species in a sufficiently systematic way that one can speak of "rainforest management" (Ellen 1996:463). The Ntumu practice of preferentially sparing particular species, especially those characterising old secondary forests, such as *Ceiba pentandra, Triplochiton scleroxylon* and *Terminalia superba,* has increased the density and distribution of such species over many centuries. All of these trees are light-demanding pioneers that persist in the forest canopy. A particular human cultural action, the selective sparing of these trees, and a natural ecological process, the favoring of these light-demanding species in swidden clearings (Letouzey 1985), have the same effect on the forest. Both increase the abundance of these culturally valued and useful species in the forests of this area. Ironically, the long-term sustainable strategy of swidden-farmers like the Ntumu may be responsible for the abundance of valued timber trees such as *T. scleroxylon* and *T. superba,* which makes their territory a tempting target for unsustainable levels of commercial logging.

The practice of preserving certain trees is culturally determined, and subject to change depending on factors such as market forces, population pressure and social change. Ntumu originating from Equatorial Guinea have migrated into the Ntem valley. These newcomers have different practices from the indigenous Ntumu of southern Cameroon. They keep fewer trees in their fields because in Equatorial Guinea fields are larger and the economy is more specialized towards cash-oriented production. Moreover, the floristic composition of forest in their area of origin is different and the culturally valuable species are different. These newcomers do not preferentially spare *Triplochiton scleroxylon,* because in Equatorial

Guinea this species is rare and not especially valued. These observations indicate that cultural, social and economic factors are very important in determining practices concerning remnant trees and their impact on the forest. De Rouw (1991) offers other examples of differences between foreign and native practices in Côte d'Ivoire. The native Oubi, who know their own forest very well, keep some trees in their rice fields, while the foreign Baoulé, migrants and colonizers, generally kill all the trees in the fields during clearing. It is thus impossible to understand local attitudes without integrating the historical dimension. Local people, on the whole, respect knowledge gained from past experience. However, many traditional swidden farmers around the world do not leave remnant trees in their fields. This may reflect great variation in cultural free will, history of cultivation systems, and environment.

Many populations of swidden farmers have independently created associations between trees and crops, now called "agroforestry systems," which reduce the risk of declining soil fertility in the face of increasing population pressure. But this behavior is not always reported as obvious. In traditional Ntumu society spared trees are undeniably part of the crop cultivation system, but this could be subject to change. In this currently stable situation the impact of the chain saw already exists. It is clear, that a shift in subsistence strategy could drive farmers to use tools such as the chain saw to produce larger fields for the production of cash crops. Many studies of peri-urban villages and large towns have shown that the intensification of cultivation leads to loss of crop diversity (Santoir 1992). This kind of specialization of production driven by commercialisation may contribute to the erosion not only of crop diversity but also of those traditional agricultural practices and knowledge associated with crop diversity and required for its maintenance (Ellen 1997). Crop diversity in space and time, and an agricultural strategy oriented to this diversity, are the guarantors of a sustainable dynamic equilibrium between the forest and human populations and of the conservation of the adapted ancestral practices.

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APPENDIX 1.—Species of remnant trees found in Ntumu fields at Nkongmeyos. For each species is given the total number of individuals along the edge or in a central position in the field, and their size. "Edge" means the tree's trunk was located on the limit line of the field and central means all others. Large trees are those ≥35 m tall; medium trees are 15–35 m tall; small trees are those <15m tall. Wood-hardness: A = hard; B = mid-hard; C = soft; I = undetermined.

Species (Family)	Wood hard-ness	Tree position in the field		Tree size			Total
		Edge	Central	Large	Medium	Small	
Triplochiton scleroxylon K. Schum. (Sterculiaceae)	C	28	18	40	5	1	46
Terminalia superba Engl. and Diels (Combretaceae)	C	10	21	27	3	1	31
Ceiba pentandra Gaertn. (Bombacaceae)	C	13	12	24	1	—	25
Irvingia gabonensis (Aubry Lecompte ex. O'Rorke) Baill. (Irvingiaceae)	A	12	7	16	3	—	19
Chlorophora excelsa (Welw.) Benth. (Moraceae)	B	5	11	4	10	2	16
Albizia adianthifolia (Schum.) W. F. Wight (Mimosaceae)	C	13	2	8	7	—	15
Musanga cecropioides R. Br. (Moraceae)	C	—	15	4	7	4	15
Pycnanthus angolensis (Welw.) Exell (Myristicaceae)	C	9	6	12	3	—	15
Erythrophleum ivorense A. Chev. (Caesalpiniaceae)	A	10	4	13	1	—	14
Eribroma oblongum (Mast.) Bod. (Sterculiaceae)	B	5	8	12	1	—	13
Pterocarpus soyauxii Taub. (Papilionaceae)	B	6	5	11	—	—	11
Albizia spp. (Mimosaceae)	C	7	3	1	6	3	10
Duboscia macrocarpa Bocq. (Tiliaceae)	A	3	4	4	2	1	7
Xylopia spp. (Annonaceae)	C	6	1	2	4	1	7
Canarium schweinfurthii Engl. (Burseraceae)	C	4	2	5	1	—	6
Myrianthus arboreus P. Beauv. (Moraceae)	B	3	2	3	2	—	5
Tricoscypha abut Engl. (Anacardiaceae)	C	3	2	4	—	1	8
Anthocleista schweinfurthii Gilg. (Loganiaceae)	C	2	2	—	4	—	4
Bridelia micrantha (Hochst.) Baill. (Euphorbiaceae)	C	1	3	2	2	—	4
Cordia platythyrsa Bak. (Boraginaceae)	C	2	2	2	—	2	4
Ficus spp. (Moraceae)	C	3	1	2	2	—	4
Petersianthus macrocarpum (P. Beauv.) Liben (Lecythidaceae)	A	3	1	2	2	—	4
Vitex spp. (Verbenaceae)	C	2	2	—	4	—	4
Desbordesia glaucescens (Engl.) (Irvingiaceae)	A	—	3	3	—	—	3
Enantia chlorantha Oliver (Annonaceae)	C	2	1	2	1	—	3
Zanthoxylum macrophyllum L. (Rutaceae)	C	—	3	3	—	—	3
Ficus vogelii (Micq.) Miq. (Moraceae)	C	1	2	2	1	—	3

APPENDIX 1.—(continued)

Species (Family)	Wood hard-ness	Tree position in the field		Tree size			Total
		Edge	Central	Large	Medium	Small	
Klainedoxa gabonensis Pierre (Irvingiaceae)	A	—	3	1	2	—	3
Pentaclethra macrophylla Benth. (Mimosaceae)	C	3	—	2	1	—	3
Phyllanthus spp. (Euphorbiaceae)	C	1	2	3	—	—	3
Barteria fistulosa Mast. (Passifloraceae)	C	—	2	—	2	—	2
Canthium spp. (Rubiaceae)	C	2	—	1	1	—	2
Croton oligandrus Pierre (Euphorbiaceae)	C	1	1	—	2	—	2
Ficus natalensis Hochst. (Moraceae)	C	1	1	—	2	—	2
Grewia spp. (Tiliaceae)	C	2	—	—	2	—	2
Lonchocarpus sericeus (Poir.) H. B. and K. (Mimosaceae)	C	2	—	—	2	—	2
Lophira alata Banks ex. Gaertn. (Ochnaceae)	A	1	1	2	—	—	2
Macaranga hurifolia Beille (Euphorbiaceae)	C	1	1	—	2	—	2
Macaranga spp. (Euphorbiaceae)	C	1	1	—	1	1	2
Margaritaria discoidea (Baill.) Webster (Euphorbiaceae)	A	2	—	—	2	—	2
Antrocaryon klaineanum Pierre (Anacardiaceae)	C	—	1	—	—	1	1
Berlinia spp. (Caesalpiniaceae)	B	1	—	1	—	—	1
Caesalpiniaceae undetermined species	I	1	—	—	1	—	1
Dacryodes edulis (G. Don) Lam. (Burseraceae)	B	—	1	1	—	—	1
Dacryodes macrophylla (Oliv.) Lam. (Burseraceae)	B	—	1	1	—	—	1
Desplatsia sp. (Tiliaceae)	I	1	—	—	1	—	1
Entandrophragma utile (Dave and Sprague) Sprague (Meliaceae)	B	—	1	—	—	1	1
Eriocoelon macrocarpum Gilg. (Sapindaceae)	I	1	—	—	1	—	1
Ficus sur Forssk. (Moraceae)	C	—	1	1	—	—	1
Funtumia elastica (Preuss.) Stapf (Apocynaceae)	C	1	—	1	—	—	1
Grewia brevis (Spreng.) Monachino (Tiliaceae)	C	1	—	—	1	—	1
Hallea stipulosa (DC.) O. Ktze. (Rubiaceae)	C	1	—	—	1	—	1
Irvingiaceae undetermined species	I	1	—	—	1	—	1
Khaya ivorensis A. Chev. (Meliaceae)	C	—	1	1	—	—	1
Lovoa trichilioides Harms (Meliaceae)	C	—	1	1	—	—	1
Mimosaceae undetermined species	I	—	1	—	1	—	1
Monodora sp. (Annonaceae)	I	—	1	1	—	—	1

APPENDIX 1.—(continued)

Species (Family)	Wood hardness	Tree position in the field		Tree size			Total
		Edge	Central	Large	Medium	Small	
Nauclea sp. (Rubiaceae)	B	1	—	1	—	—	1
Persea americana Mill. (Lauraceae)	C	—	1	1	—	—	1
Rauwolfia macrophylla Stapf. (Apocynaceae)	C	1	—	—	1	—	1
Ricinodendron heudelotii Müll. (Euphorbiaceae)	C	—	1	1	—	—	1
Sapindaceae undetermined species	I	1	—	1	—	—	1
Spathodea campanulata P. B. (Bignoniaceae)	C	1	—	—	—	1	1
Tetrapleura tetraptera (Schum. and Thonn.) Taub. (Mimosaceae)	C	1	—	1	—	—	1
Tetrorchidium dimosthemum (Euphorbiaceae)	C	1	—	—	1	—	1
Tetrorchidium sp. (Euphorbiaceae)	C	1	—	—	1	—	1
Xylopia quintasii Auct. (Annonaceae)	C	—	1	1	—	—	1
Total		188	167	231	102	22	355