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Tree management as part of two farming systems in the wet forest zone (Ivory Coast)

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ABSTRACT

In South-West Ivory Coast smallholders cultivate coffee and cocoa in a rainforest environment. Two farming systems, one practiced by the autochthonous population, a forest people, the other by immigrants from the savanna, are compared: selective felling versus clearfelling, light burning versus excessive burning, and no soiltillage versus soiltillage.

The autochthonous system, being less destructive to the environment, tolerates a variety of fallow and high forest trees on the plantation, serving all sorts of purposes. The immigrants, due to their more drastic actions, create a different tree population on their field, yielding different products.

KEY-WORDS: *Treecrop cultivation - Fallow - Taï rainforest - Usefull trees.*

RÉSUMÉ

Ce sont des petites plantations villageoises, installées dans la forêt tropicale humide, qui assurent, dans le Sud-Ouest de la Côte-d'Ivoire la production de café et de cacao. Deux systèmes de cultures y sont pratiqués, l'un par la population autochtone, l'autre par des immigrants venus des régions de savane. De nombreux points les différencient : le type de défrichement qui est sélectif ou non, l'intensité du brûlis, l'existence ou non d'un travail du sol.

Le système autochtone, moins agressif à l'égard de l'environnement, assure le maintien sur les plantations d'arbres de forêts primaire et secondaire dont les fonctions sont très diverses. Les immigrants, par contre, du fait d'interventions plus marquées sur le milieu, provoquent une modification de la population arborée qui fournit elle-même d'autres produits.

MOTS-CLÉS : *Culture arborée - Jachère - Taï-forêt tropicale humide - Arbres utiles.*

1. — INTRODUCTION

The closed evergreen forest area of South-West Ivory Coast has become important for cocoa and coffee production. Attracted by local conditions such as the abundance of forest, many immigrants, usually from savanna regions, have established themselves, in order to start, like the autochthonous farmers, a treecrop plantation. In the study area between the Cavally River and the Taï National Park, the savanna people (Baoulé) slightly outnumber the native Oubi at present.

Though both groups are exclusively cocoa and coffee farmers, the Oubi and the Baoulé differ greatly in cultivation methods, especially in the way they manage the original rainforest. The traditional cultivation system of the Oubi, based on rice, and the Baoulé system, based on yam, in the Taï region is quite well known (MOREAU

& DE NAMUR, 1978; DE ROUW, 1979; GNESIO TEHE, 1980). The development of the fallow and of the soil under fallow, following one ricecrop after clearing a primary forest, has been described by ALEXANDRE *et al.* (1978), FRITSCH (1982) and JAFFRE & DE NAMUR (1983). No publications are yet available on fallows on sites which have suffered a more intense form of disturbance.

The local rainfall is about 1,950 mm per year, the greater part falling within two rainy seasons. Foodcultivation is performed in the heaviest rainy season. The soils are welldrained leached ferralitic soils with slope inclinations up to 20 %. Coffee is mostly cultivated on the red clay soils, including gravel in the topsoil (ferralo-ferric Acrisol, FAO). More favourable for cocoa farming are the yellow sandy-clay soils without gravel (xanthic Ferrasols, FAO).

Treecrop farming is often recommended in the wet tropical lowlands, provided certain soil and forest conservation measures are taken. Also shadetrees and intercropping with legume trees are reported to be beneficial (NYE & GREENLAND, 1960; WEBSTER & WILSON, 1967; AHN, 1974; RUTHENBERG, 1976). It is a custom in many countries.

A striking feature of the Baoulé planting system is the practice of clearfelling. The forest people on the contrary never turn to denuding a forest soil. Neither do shifting cultivators in the high forest of Nigeria (OKAFOR, 1980), Sierra Leone (AYODELE, 1968), Gabon (SAINT-AUBIN, 1963; NICOLAS, 1977) and Congo (PANMAN & VAN DE POL, 1985).

COLLINET (1984) has quantified soil losses under rice and yam conditions in Taï.

IRVINE (1961), ROLLET (1963) and RUTHENBERG (1976) mention upland rice-farming in association with a clearing system which permits some of the biggest trees to survive. These habits are linked to the wet closed forest. In the drier forest and in savanna regions a cropping system dominates where tubers are grown and all vegetation is either burnt or girdled, but not felled, and left standing as dead timber. These descriptions fit with the Taï situation. There we see both practices at work side by side for the savanna people have kept their former cultivation methods.

Concerning the forestdwellers, a reason for not felling a tree on a field may lie in its usefullness. OKAFOR (1980) in Nigeria finds a density of 2.5 trees yielding edible product per hectare cultivated land. The majority consist of *Irvingia gabonensis* (Aubry-Lecomte ex-O'Rorke) Baill, *Myrianthus arboreus* P. Beauv., *Treculia africana* Decne, *Xylopia aethiopica* (Dunal) A. Rich. *Pentaclethra macrophylla* Benth. In the natural forest the density of trees yielding in some way edible products—he notes 150 species—is 3 per hectare. So a policy of encouraging the development of the most useful trees is evident. In Sierra Leone (AYODELE, 1968) the oilpalm, mango and *Cola nitida* (Venth.) Schott & Endl are left standing, obvious for their fruits and seeds. For Gabon SAINT-AUBIN (1963) names *Irvingia gabonensis* and *Coula edulis* Baill, and NICOLAS (1977) in addition mentions 4 other valuable seed producing trees, not occurring in Taï. They appear in densities of 2.8 trees per hectare on cultivated land. PANMAN & VAN DE POL (1985) for the wetter part of the Congo, noticed *Pycnanthus angolensis* (Welv) Warb as a big tree with too valuable a wood to be cut down during the land preparation. All authors cited above remark that trees with hard wood are often left standing.

This article describes how fallow trees and high forest trees interfere with the Oubi and Baoulé cropping system and how the people judge the impact of these cropping patterns on the environment.

2. — METHOD

Regular visits are made to the South-West Ivory Coast from 1979 up to the present day. Various agronomical and botanical research was carried out. The results dealing with this article were mainly obtained during the dry season of 1984, the period during which forest is cleared for cultivation. Many smallholder plantations were visited and their workers questioned on their agricultural methods. 5 Oubi farms, located in 2 villages, and 5 Baoulé farms in 3 villages (total of 41 ha) were studied more closely. In adult plantations all trees including the crop were counted and if possible determined. In young plantations 2 samples of 100 m² each were taken, all woody plants counted and determined. A map was drawn of the arrangement of shade plants and crop. The farmer was questioned on each tree (other than the crop) present in his field. What is the reason for its being there. Was the tree planted or had it arrived spontaneously. Was it encouraged in its growth or simply tolerated. Tolerated for reasons of its own specific qualities or tolerated because of the plantation as a whole was too neglected to care much about a peculiar tree. Finally he was asked to express his opinion on his own holding and on those of the other ethnical group.

3. — RESULTS

3.1. CLEARING

The way people prepare a piece of forest for cultivation, often close to climax vegetation, reflects the habits of their country of origin.

Oubi men fell all but 2 or 3 very large trees per hectare, relicts of the rainforest. These trees are usually left standing as their removal is not thought worth the considerable effort involved, either for the extremely hard wood (*Dialium aubrevillei* Pellegr., *Erythrophleum ivorense* A. Chev., *Klainedoxa gabonensis* Pierre ex Engl., *Lophira alata* Banks ex Gaertn, *Samnaea dinklagei* (Harms) Keay), or for the large buttresses (*Ceiba pentandra* (L) Gaertn, *Bombax buenopozense* P. Beauv., *Piptadeniastrum africanum* (Hook f) Brenan). A variable number of smaller trees are left untouched. Either a poor developed crown makes them harmless to the crop, or the wood is hard *(Diospyros ssp.)* or the tree belongs to a species which hardly survives exposure to full sunlight. Some trees are preserved for their usefull seeds *(Irvingia gabonensis, Ricinodendron heudelotii* (Baill) Pierre ex-Pax, *Coula edulis)*, or for religious reasons. Up to 19 trees over 15 m high were counted per hectare, and the number was not considered exceptional. The trees are appreciated by workers on the field for the comforting shadow. Finally, the Oubi suppose the trees contribute to re-establish the forest once the field is abandoned.

After drying the debris is given a quick burn, rice is sown immediately with the help of a digging stick. While the foodcrop ripens, the cashcrop seedlings are planted in between.

The Baoulé cut down most of the undergrowth and the smaller trees. The material is burnt in piles, packed around the bases of all larger trees to kill them (fig. 1). Burning is repeated until all firewood is spent. In the topsoil, which has become bare for the disappearance of all wood lying about, moulds are made and yam is planted. It takes at least one month to free the soil of all wood (per hectare), a necessity for moulding. It takes another month for the yam to cover the ground. Even before the foodcrop is harvested, coffee and cocoa are planted. Though no high forest tree is tolerated because of its too strong competition with the treecrop, some trees enjoy a narrow escape due to lack of firewood or to a thick and waterly bark *(Pycnanthus angolensis)*. Table I *a* shows all trees in the survey, forming part of the original

forest, which have survived clearing and burning. Frequency and uses, if any, is given, too.

A considerable number of forest tree products appear on the local market: fruits and seeds of *Beilschmiedia ssp.*, *Calpocalyx aubrevillei* Pellegr, *Coula edulis*, *Dialium aubrevillei*, *Irvingia gabonensis*, *Pentaclethra macrophylla*, *Ricinodendron heudelotii*. All of those trees appear on fields as relicts, in secondary and even primary forest. By not felling an economic valuable tree on one's field, collection of the products is made easier. Chiefly the Oubi make use of forest products, but a commercialisation is not infrequently in the hands of the immigrants.

FIG. 1. — Clearing the forest for a treecrop plantation. The Baoulé, having cut down and burnt the smaller trees, make piles of wood around the bases of the larger trees to burn and kill them. The work is repeated untill all trees are dead or all firewood spent.

3.2. SHADE FOR THE YOUNG TREECROP

It is a well accepted fact by both groups that shade is needed to nurse the seedlings. However, the relicts on the Oubi fields are unfit to serve this purpose. Instead, among the fast-growing pioneer trees (weedtrees), overgrowing the rice even before the harvest, certain species are selected, suitably spaced, to protect the coffee and cocoa. Undesirable trees as well as vines are removed. The general objective is to ensure a light, even shade, well above the young crop. The best pioneer trees are those whose natural decline after a couple of years coincides with the crops diminishing needs for protection.

The Oubi farmers suppress *Macaranga ssp.* for its large spines on the trunk and its habit of gregarious growth. Removal is simple for the germination tends to be synchronious and after more than two rounds of weeding no further germinations

occur. The growth of *Trema guineensis* L. Blume is encouraged by thinning the fallow population until the crowns of *Trema guineensis* cast a regular shade. Where *Trema* is lacking, *Musanga cecropioides* R. Br. takes its place. The usual abundance of seed of *Trema* and the property of *Trema* and *Musanga* to overcome repeated weeding, facilitate the installation of the desired canopy. Besides, *Trema* starts to degenerate after 3 years and 5-year old die-hards are easily disposed off by girdling. A stand of *Musanga*, being a more massive tree, is more difficult to control. For how other pioneers are valued see table I *b*. In general little weeding is done. There is sufficient shadow to prevent the crop being choked by herbaceous weeds. In fact, the system

TABLE I. — *Occurrence and uses of trees on cocoa and coffee holdings, Taï region, Ivory Coast. Owner Oubi (forest people) or Baoulé (immigrant from the savanna). Sample of 41 ha.*

Table 1.a Trees not killed while clearing the forest

Name	Oubi	Baoulé	Uses
ANTHOCLEISTA NOBILIS LOGANIAC.		r	None. Difficult to burn for abundant water in the trunk.
AUBREVILLEA KERSTINGII MIMOSAC.	r		None. Hard wood.
BEILSCHMIEDIA MANNII LAURAC.	F		Seeds are a condiment. On the market.
COLA NITIDA STERCULIAC.	r		Seeds are a stimulant. On the market.
COULA EDULIS OLACAC.	F	r	Edible seeds. On the market.
DIALIUM AUBREVILLEI MIMOSAC.	F		Hard wood. Pulp round the seed is edible. Occasionally women extract salt from the ashes of fallen branches which have been burnt to make soap. On the market.
DIOSPYROS SANZA-MINIKA EBENAC.	F		None. Hard wood.
ELAEIS GUINEENSIS PALMAE	a	r	Severe competitor to the treecrop, but its products, oil, palmwine and construction material are valuable. On the market.
KLAINEDOXA GABONENSIS IRVINGIAC.	r		None. Hard wood.
MONODORA MYRISTICA ANNONAC.	r		Seeds sold on the market, perhaps for medical use. Tree is unprofitable for cocoa.
NEWTONIA DUPARQUETIANA MIMOSAC.		r	None. Too big to be felled or burnt. Unprofitable to the crop.
PYCNANTHUS ANGOLENSIS MYRISTICAC.		F	None. Difficult to burn for the large quantity of water stored in the trunk. Severe competitor to the crop.
RICINODENDRON HEUDELOTII EUPHORBIAC.	F		Seeds are a condiment. Occasionally women extract salt from the ashes of fallen branches which have been burnt to make soap. On the market.

Table 1.b Trees used for nursing the young crop

Name	Oubi	Baoulé	Uses
ALBIZIA ADIANTHIFOLIA MIMOSAC.	r		Good shade for the crop.
ALBIZIA ZYGIA MIMOSAC.	r		Good shade for the crop.
FAGARA MACROPHYLLA RUTAC.	F		Flowers a condiment, bark a medicine. Trunk and leaves are very spiny, therefore when felled, the vigoreous coppice growth is very inconvenient. The small crown of the adult tree is less annoying.
FICUS CAPENSIS MORAC.	F	r	Shadowtree for young crop but difficult to dispose off because of plentifull coppice after felling.
FICUS EXASPERATA MORAC.	r		Shadowtree for young crop.
FICUS VOGELII MORAC.		r	Shadowtree for young crop. Bark, fruits and roots are a medicine.
HARUNGANA MADAGASCARIENSIS HYPERICAC.		r	Shadowtree for the young crop.
MACARANGA BARTERI EUPHORBIAC.	r		Inconvenient as a shadowtree because of of the spiny trunk.
MACARANGA HURIFOLIA EUPHORBIAC.	F		Not the best shadowtree because of the spiny trunk. Abundant in neglected fields.
MUSA SSP MUSAC.	r	a	Planted shadowtree. Fruits eaten and sold on the market.
MUSANGA CECROPIOIDES MORAC.	a	r	Good shadowtree. Sap used medically.
MYRIANTHUS ARBOREUS MORAC.	F		Buds and fruits edible.
RAUVOLFIA VOMITORIA APOCYNAC.	a		Rather good shadowtree. Roots are medically used.
TREMA GUINEENSIS ULMAC.	a	F	The most appropriate shadowtree, Density easy to control, short lifespan.
VISMIA GUINEENSIS HYPERICAC.	F	F	Good shadowtree, despite of its early degeneration after 2 or 3 years.

tends to be extensive to the point that the development of the crop is slowed down, such is the vigour of the regrowth. A well-kept 2 year old plantation contains an average of 10 shadowtrees per 100 m^2 and 8 cocoa or coffee plants.

The Baoulé, after the yamcrop, have to cope with many heliophyl forbs, grasses and vines which have rapidly invaded the plots being rather open due to repeated burning, weeding and some soiltillage. It is no longer possible to raise fallowtrees according to one's wishes. Banana, taro and some fruit trees replace most of the pioneers. As free space is continually replanted with new seedlings, a young plantation may carry a double amount of croptrees: an average of 13 foodcrops often herba-

Table 1.c Trees present in an adult plantation, mostly younger than the crop

Name	Oubi	Baoulé	Uses
ALBIZIA ADIANTHIFOLIA MIMOSAC.		r	Beneficial for the crop.
ALBIZIA ZYGIA MIMOSAC.		r	Beneficial for the crop.
ARTOCARPUS COMMUNIS MORAC.	f		2 types planted, 1 with edible fruits and no seeds, 1 with edible seeds. On the market. Unprofitable for the crop.
AUBREVILLEA KERSTINGII MIMOSAC.		r	Beneficial for adult crop.
CARICA PAPAYA CARICAC.		f	Spontaneous or planted. Fruits are eaten.
DISCOGLYPREMNA CALONEURA EUPHORBIAC.		r	Rather strong competitor for water and nutrients. But its plentifull red fruits, present many months a year, attract birds who can be shot with a catapult and eaten.
ELAEIS GUINEENSIS PALMAE	r	F	see Table 1.a.
FICUS EXASPERATA MORAC.	r	r	Tolerated. Leaves used as sandpaper.
FICUS VOGELII MORAC.		r	Tolerated. See Table 1.b.
FUNTUMIA ELASTICA/AFRICANA APOCYNAC.	f		Spontaneous and planted. Latex for all sorts of repairs (shoes, bicycle tyre) and toys. Wood for the fabrication of masks.
GARCINIA AFZELII GUTTIFERAE		r	Unprofitable for the crop when big. Twigs and roots used as toothbrushes.
MICRODESMIS PUBERULA EUPHORBIAC.	F		The many coppice shoots are for making traps. Medically employed against gonorrhoea.
NAUCLEA DIDERRICHII RUBIAC.		r	Not harmfull to the adult crop.
NAUCLEA LATIFOLIA RUBIAC.		r	Savanna tree. Introduced and planted by a Baoulé family. Not harmfull to the adult crop, edible fruits.
PERSEA AMERICANA LAURAC.		F	Not bad for the crop. Planted. Fruits are edible and sold on the market.
RICINODENDRON HEUDELOTII EUPHORBIAC.	F		See Table 1.a. Sometimes planted.

ceous (taro, cassava and bananas) and 3 fallowtrees per 100 m^2 protect the crop. It is noteworthy that nor the district market, nor the local population can possibly work up this foodproduction. The surplus is left on the field. The Baoulé are liable to look upon each fallow or high forest tree as a possible rival to the cashcrop and the young tree is disposed off as soon as the crop expresses the slightest sign of suffering. Generally, Baoulé farmers by working hard, 2 rounds of weeding a year, successfully get rid of the weeds. Their efforts result in better and earlier yields.

3.3. Forest trees mixed with an adult treecrop

It is noticed by forest people and by immigrants that coffee and cocoa trees tolerate some foreign trees among them, and that the crop may benefit from certain species. Thus after the disappearance of the fallowtrees *(Trema, Musanga,* etc.) and the foodcrops (banana, taro), seedlings of appropriate species are favoured to establish themselves. They are raised either for their proper usefulness (oilpalm, avocado, *Funtumia ssp., Garcinia afzelii* Engl.), or to sustain the coffee and cocoa production (many legume trees).

A piece of forest cleared in the Oubi way, often becomes too rich in trees in the period that pioneer trees nurse the cashcrop. Many trees take root due to the lack of attention payed to the plantation. The plot may resemble a fallow in the normal course of succession. *Alchornea cordifolia* (Schum. & Thonn.) Müll. Arg., *Fagara macrophylla* Engl., *Ficus capensis* Thunb., once established, are particularly difficult to get rid off. The situation becomes worse, when an insufficient burn has permitted an abundant growth of coppice. Less choice is left to install a profitable mixture of forest trees and crop. Therefore, many trees appear undeliberately.

The Baoulé, having finished with the mass of vines and shrubs, are now troubled with the falling down of the dead trees. Meanwhile care is taken to select seedlings of tree species ranging from harmless to beneficial with respect to the crop. A rather dry site may turn a tree into a severe competitor, while the same species, growing under more humid conditions, is rendered harmless *(Coula edulis)*. An exception is made for the oilpalm. Though admittedly held responsible for yield reduction, the palm is tolerated in small numbers, its products oil, construction material and palm-wine being indispensable.

Some mutual influence exists between forest people and immigrants. The numerous spontaneous trees on an Oubi holding can not be felled without damaging the crop. Usually they are killed the Baoulé way, by small fires lit at the base of the trunk and by girdling, thus simultaneously avoiding the development of shoots. When burning is difficult, a Baoulé may resort to felling a tree, at times hiring an Oubi to do so. Lastly, immigrants are held responsible for having introduced and spread many fruit trees, some of them are intercropped with cocoa and coffee (avocado, *Citrus ssp.)*.

Figure 2 and figure 3 illustrate the development of a typical Oubi and Baoulé holding. Densities of trees per hectare is given alongside. An adult Oubi plantation may carry an equal number of forest trees as a Baoulé field, but usually the plantation shows a more forest-like appearance. 600-1,000 cashcrop trees per hectare (Oubi) do not reach the advised density of 1,350/ha (Société d'Assistance Technique pour la Modernisation de l'Agriculture en Côte-d'Ivoire). The Baoulé, due to a habit of filling in each gap with new plants, often create to thick a stand.

Table I *c* shows the trees observed in adult plantation. All along, the Baoulé tend to be more hostile towards the presence of a fallow or forest tree and less inclined to enjoy its usefulness.

Clayton (1958) reports cocoa stands in Nigeria mixed with *Cola nitida* (Vent.) Schott & Engl. and *Cola acuminata* (P. Beauv.) Schott & Engl. and oilpalm. Cola trees are found to be unfavourable for the main crop. The dense spreading crowns are somewhat higher than the cocoa, the latter being gradually overtopped and suppressed. In Taï, mixtures of cocoa with Sterculiaceae in general are avoided owing to their superior vigour (Gnesio Tehe, pers. comm.).

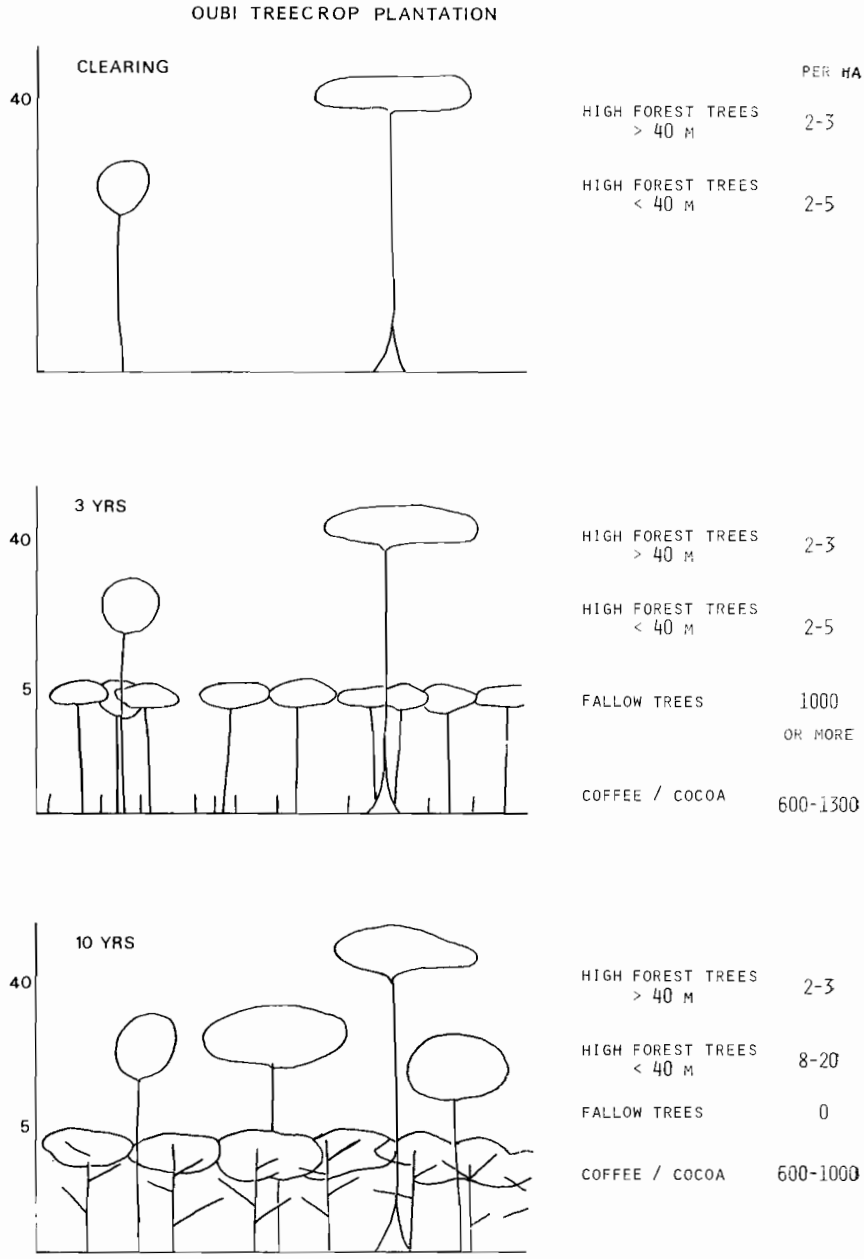

FIG. 2. — Density of trees on a typical Oubi holding.

2 *a*. After land preparation.
2 *b*. In a young plantation.
2 *c*. In an adult plantation.

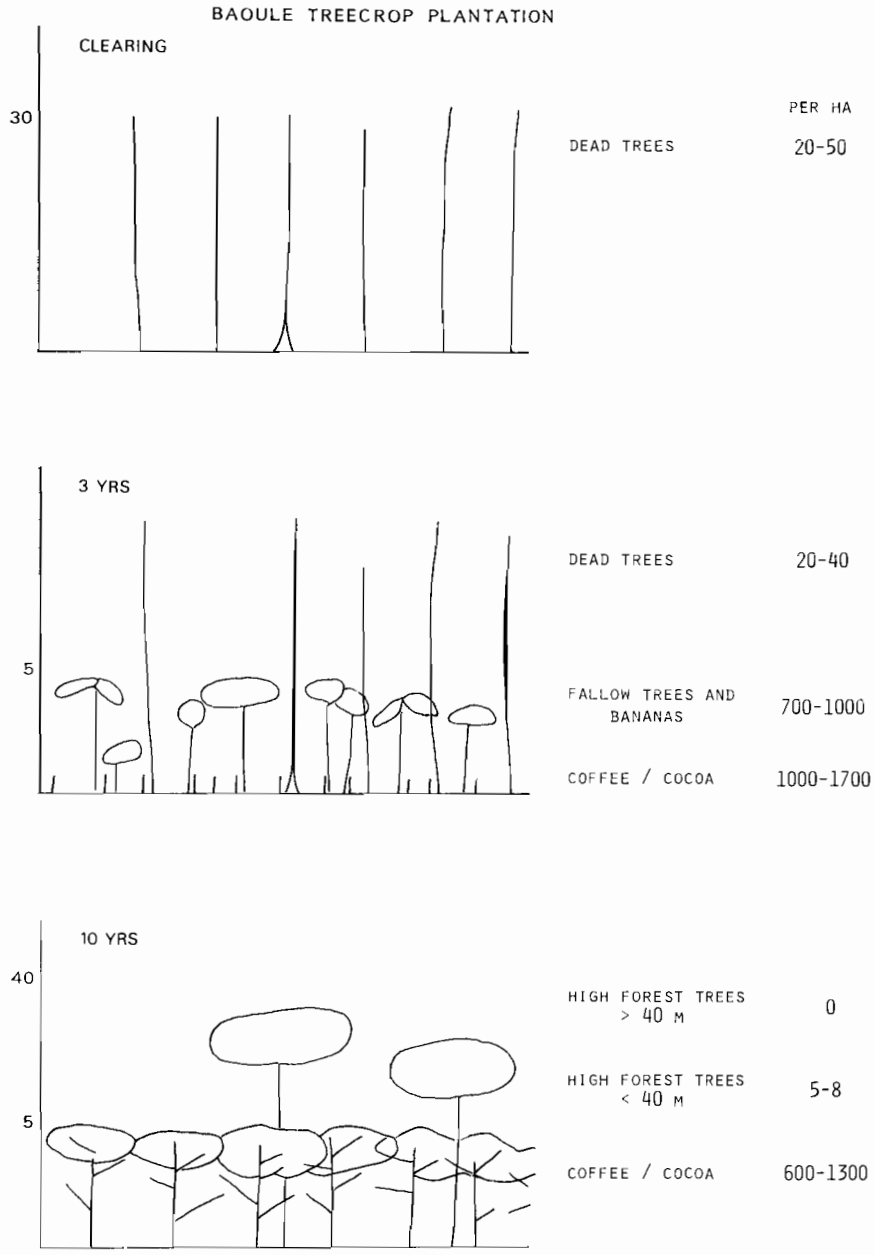

FIG. 3. — Density of trees on a typical Baoulé holding.

3 *a*. After land preparation.
3 *b*. In a young plantation.
3 *c*. In an adult plantation.

4. — DISCUSSION, CONCLUSION AND SOME OBSERVATIONS

In the year 1984 the Ivory Coast became the first cocoa exporting country in the world, and third for coffee. The greater part of this production comes from smallholder estates not unlike the ones described above. In the Taï region yields are low, rarely exceeding 1 ton/ha.

The shortcomings of the Oubi concern the often serious neglect of the holdings, bringing on late and low yelids. There are some reasons explaining the Oubi indulgent attitude towards the vigour of the secondary forest. The majority of the farmers have more area forest at their disposal than the average immigrant family (RUF, 1984). Many Oubi prefer a large un-kept plantation to a few well-managed fields. Thus putting in less work for the same income. The tree population on coffee and cocoa farms supplies a variety of products. In consequence, the loss in cashcrop revenue is not so much felt. Finally, Oubi farmers give explicite ecological reasons for not felling as many trees as the Baoulé do: clearfelling is thought to provoke the encroachment of the savanna; thus bringing along a drier climate. The importance of some surviving forest trees was pointed out by NYE & GREENLAND (1960): assisting reseeding the fallow, helped surely by birds resting on its branches (ALEXANDRE, 1977). FRITSCH (1982) suggests that, by maintaining a forest-like microclimate in the soil nearby the living tree, the recovering of the soilfauna proper to a rainforest will accelerate. We consider the habit of leaving some of the high forest trees to survive on the field, the use of shade trees to nurse a young plantation and the practice of intercropping with valuable trees, as soil and forest conservation methods. The Oubi, who employ these methods better and more frequent than the Baoulé, value those methods as defenders of the climate.

The Baoulé obtain higher yields thanks to a more intensive exploitation of the forest. The occupation period is still short, for most of the immigrants were not there 10 or even 5 years ago. CUNNINGHAM *et al.* (1961) for Ghana, showed that much greater yields of cocoa are obtained on clear-felled land, but later admitted (CUNNINGHAM, 1963) that effects of soil degradation were not examined. Two examples are known from West Africa where immigrants move from a drier region into a wet forest to start treecrop plantations. In both cases they keep their practices of clearfelling, yamcultivation, intensive weeding and burning. Both the Bisa area, Ghana (MOOR, 1932), and the Yarouba land, Nigeria (UPTON, 1967-1968) are former cocoa producing districts which have degenerated to shrubland and are unfit for cocoa farming since.

Besides the preservation of some forest trees on a field, other factors interfere with landconservation. COLLINET (1984) has quantified one for Taï: using rainfall simulation to study soil erosion under various traditional tillage practices. Soil losses were assessed at the onset and at the end of the rice cycle. In both cases erosion remained negligible (below 0,5 $t.ha^{-1}.year^{-1}$). This result may be ascribed to the protecting effect of the undisturbed forest root mat. Under Baoulé moulding conditions, erosion is more severe (multiplication by a factor 25 or more). The increased soil micro-relief is not sufficient to hamper the accelerated removal by runoff of the detached particles from the moulds microslopes.

The impact of other factors has yet to be defined, like the losses of soil fertility due to leaching. In the case of yam the soil lies bare for a much longer period.

To what extend are a Oubi treecrop plantation and a Baoulé treecrop plantation capable of performing the same restoring functions as a normal post-fire succession? If a secondary forest is replaced by a treecrop (more or less mixed with forest trees), how high is the price to be payed in terms of loss of nutrients, soil degradation and eventually in yield reduction? And how is the price best payed? Some of this type of research is now on course.

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