

TROPICAL DEFORESTATION AND MAYA SILVICULTURE: AN ECOLOGICAL PARADOX

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My main interest in the past years has been the study of the vegetation and flora of tropical Mexico. My studies as well as the studies of my colleagues and students in many different regions of the country show that there is a great diversity of vegetation types and a complex flora throughout the area of our interest.

The complexity of the vegetation and the limited knowledge of the flora available to identify the species, influenced me to concentrate my interest on one state of Mexico, Veracruz, that has a great diversity of environments and a rich flora (Gómez-Pompa, 1973).

Very early in my studies I learned that humans have great influence on the variation and distribution of the vegetation and that species distributions were strongly influenced by their actions. This fact reinforced my decision to study the successional process in the tropical lowland areas of Veracruz as a means of obtaining information that would explain the vegetation patterns that we were finding all over the humid lowlands. Most of the results of the studies of our research group in rain forest regeneration have been published or are in the process (Gómez-Pompa, Vazquez et al. 1976; Gómez-Pompa & del Amo 1985).

The project for the study of the Flora of Veracruz is well underway and the most innovative contribution has been the creation of a floristic data base and an information system that can be permanently updated and used in all

our botanical studies in Veracruz (Gómez-Pompa, Moreno et al. 1985).

In our travels all over the tropics of Mexico we became more and more aware of the widespread deforestation process and the speed with which it is occurring. Even the forest reserve of Los Tuxtlas Biological Station of UNAM (National Autonomous University of Mexico), which was our main experimental area, was not exempted and more than 20% of the forest was cut by landless farmers. We also became aware that this deforestation process was occurring not only in Mexico but in other countries as well.

The objective of this paper is to present some reflections about tropical deforestation in Mexico in the light of some studies in Veracruz and the more recent ones I have been carrying on with my colleagues at INIREB-Yucatán (Sosa et al. 1985).

TROPICAL DEFORESTATION.

In the academic and professional media there is no doubt of the important role that tropical forests play in the protection of natural renewable resources: water, soil, flora and fauna. Many papers have been written on the subject and meetings at a high scientific level have provided us with the basic arguments of this important function of forest resources.

In spite of the seriousness of the arguments, the present loss of forests and forest resources is alarming, especially in most tropical countries, where a high rate of deforestation is occurring (Au-

breville, 1947; Farnworth & Golley 1974; Gómez-Pompa et al. 1976; Goodland & Irwin 1975; Lanly, 1983; Whitmore, 1984). The problem becomes even greater because of the lack of sufficient programs on reforestation that could replace, in a reasonable time, the resources that have been lost.

As scientists working in the tropics we have no doubt about the important role that forests play in nature and its beneficial effects for mankind. This perception of forest values is an incontrovertible fact. The respect and admiration for trees and forests that humans have, whether belonging to an urban, industrial, or rural society are certainly linked to the thousands of years of evolution of the human brain. Our ancestors lived in or near the forests and depended on them, as they provided a good portion of their subsistence resources. The forests, and especially the rain forests, were also places of respect since some of their "enemies" (large predators and "poisonous" animals) lived and were hidden in them. This surely explains the different feeling we have in front of a tree or a rain forest than the one we have toward a grass or a savanna. This feeling toward trees and forests is a good example of *biophilia* (Wilson, 1984) and helps explain our feeling of need, appreciation and respect for nature, parks and forests as the maximum expression of places for relaxation and recreation.

The importance that modern society gives to the protection of these sites is due more to psychological reasons than to practical ones since we do not depend on these locations for subsistence.

On the other hand many traditional societies that depend on forest lands for survival have a very different perception of forests, their management, and conservation. They treat the forests with

great respect (Gómez-Pompa, 1985a). The Maya for example used to ask permission of their gods for felling the forests for their milpa agriculture. For the Tsembaga in New Guinea, the forests are a worship motif (Rappaport, 1972). These attitudes become understandable if we realize that these societies depend on the forests and forest soils to obtain many of their basic needs.

The different perception of the forest and its resources by these two cultural groups (modern vs traditional) is the cause of strong contradictions (i.e., recreation vs subsistence), in spite of having the same atavistic roots.

The protection and the use of the rain forests mean two entirely different things for a subsistence farmer who lives in and from the forest, and for an urban person who only knows the rain forest from a photograph or from watching TV. The first has to make decisions on a daily basis for the future of his resources, so whatever he does is conditioned by forest survival. The second one often has to make decisions that will affect the rainforest regions without his being aware of it. The most important decisions for the future of these areas and their inhabitants are made by members of the dominant urban society; a society which, paradoxically, is also the promoter of parks and nature conservation.

Agricultural and forest production of the tropical forests is also perceived in a completely different manner by the subsistence farmer mentioned before than by a commercial farmer. The subsistence farmer bases his actions on successful traditional experience to insure forest survival in the area. The latter sees the forests and soils only as a source of cash. The first one has a peasant economy strongly based on his survival

which is linked to environmental conservation and less oriented to trade and market. The second one is basically oriented to the market as a way of survival.

This difference in perception in relation to the protection and production of the forest regions is one of the main causes of deforestation in the tropics and is the one to which I will refer in this paper.

I don't think it necessary to make another general review of what is already known of the problem of tropical deforestation. Many workshops and papers have been dedicated to this subject (FAO, 1981; Myers, 1980; Tucker & Richards, 1983; UNESCO et al., 1978; USSD, 1978). In spite of the lack of agreement on the rates of deforestation and the urgency of the problem, it is openly acknowledged that tropical deforestation is a current trend for the tropics that should be better understood, and in several regions and countries has become critical.

On the other hand, we all know of the great difficulties of doing good tropical silviculture and forestry and how complicated it is to develop programs on silviculture and reforestation on a long term basis in the tropics (Baur, 1968; Dawkins, 1958; Mergen, 1981).

This coincidence between a weak tropical silviculture together with vast deforestation, has produced the present critical situation in many tropical countries.

The urgency for trying to find a general solution to this problem is evident. In order to understand the problem it seems necessary to make some analysis of various local situations and perhaps from them, become able to define the general problem and then try to find some solutions.

DEFORESTATION OF THE MEXICAN TROPICAL LOWLANDS. I will use some examples from Mexico to analyze the problem and with it illustrate one approach I can suggest for the solution of the acute problem of deforestation of the tropical Maya area.

Obviously, the first thing we must do is to define the problem of deforestation. Is it a real problem? Because if it is not, there is no need to be worried about it; but if it is, it is necessary to explain for whom. Also, it will be necessary to identify the persons affected by the problem and to analyze the consequences of not taking action. It will also be essential to identify those involved with the problem and to try to understand their reasons.

The problem of deforestation of the Mexican tropics has two components: the reason why it is deforested and the reason why it is not reforested. We must try to understand these aspects so we can suggest feasible solutions.

The forests of the lowland tropics of Mexico and Central America are subjected to an intensive deforestation process. There are not reliable figures on the rate of deforestation, and maybe we will never have them, because the two processes, reforestation (natural as well as artificial) and deforestation are very dynamic.

In Mexico the forests are cut mainly to use their soils for agriculture. This is done through two main processes: by governmental programs of directed colonization and by spontaneous colonization by individual actions (Gómez-Pompa et al., 1976; Halffter, 1983).

DIRECTED COLONIZATION. In the case of programs of directed colonization (Table 1) the first step is to cut the valuable timbers (which we know include only a few species) and obtain the benefits of their market value (by the

COMMON STEPS IN DIRECTED COLONIZATION

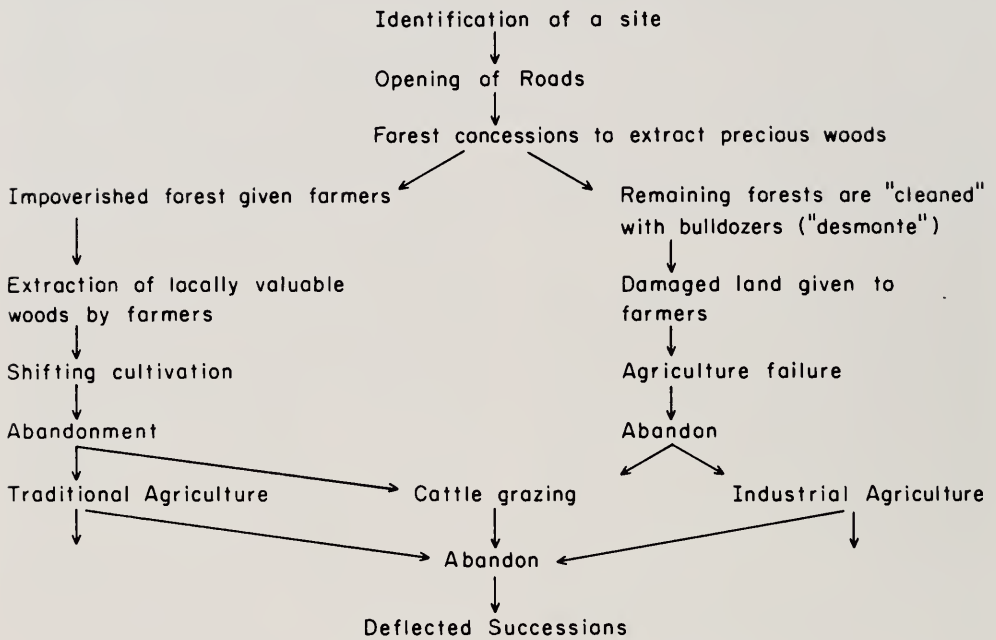


TABLE 1. Common steps in Directed Colonization Programs.

concessionaires of the cutting or "desmonte" as the process is known in Spanish). Once the "precious" woods are taken from the area, the remaining forests are completely removed by bulldozers and the land given to the farmers who will be the "beneficiaries" of the colonization program. The next step is more varied depending on the purpose of the colonization program, the degree of deforestation and knowledge of the farmers. In the Maya area the most frequent step is the use of the land with a sort of shifting agricultural technique and after some years of grazing (Fig. 1). These areas are very seldom dedicated to an intensive permanent agriculture or silviculture. Frequently these areas are abandoned and an interrupted succession occurs ("bush or grass fallow", sensu Denevan, 1981) instead

of the common forest fallow of swidden agriculture.

Directed colonization is always financed by large investments (generally from the Federal Government). The participation of local farmers is minimal and mainly as paid hand labor to help in the different processes of clearing, transportation of wood, etc. And occasionally, if the farmer is a beneficiary of the colonization program, as receptor of credits for starting agricultural activities in the area.

In the tropical areas of Mexico, with a few exceptions, the process of forest exploitation is very similar to the one mentioned before. The economic resources are also external to the area and the farmer participation is also as hand labor. Once the valuable wood resources have been extracted, the area is aban-



Fig. 1. Cattle ranching is the most important activity in lowland areas in tropics and the ultimate cause of deforestation in the Maya area.

doned and shifting agriculturalists take over the site for a few years. Often the abandoned fallows are converted to grazing land.

It is a well known fact that in the Mexican tropics we have never had long term projects of forest exploitation. Regeneration is never included in the management plans. The same applies to commercial forest plantations. There are almost none in the lowland tropics of Mexico (except a pine plantation in a savannah region of Oaxaca). The well known techniques for forest regeneration and silviculture are never followed, and are used only on a small experimental scale in research stations, as happens in other tropical countries as well (Budowski, 1981).

The results of all these facts are well known; forest regeneration does not occur in these forest exploitation and colonization sites. Instead, a secondary savanoid forest takes its place, which is

suitable for shifting agriculture. In areas with an abundance of landless farmers (most of the Mexican tropics) this is precisely what occurs, with the additional problem that this occupation often is illegal and the farmers, well aware of that, do not plan on a medium or long term basis.

The rest of the story is well known; many of these areas eventually are turned into areas for grazing, forcing the landless farmer to move into other areas of forest exploitation and start another cycle.

This intense process of conversion of forest systems into agroecosystems is very well known and understood not only for Mexico but for many other tropical countries as well.

SPONTANEOUS COLONIZATION.

The process of spontaneous colonization (Table 2) of the forests is more difficult to describe for there are multiple factors that promote it and the proces-

COMMON STEPS IN SPONTANEOUS COLONIZATION

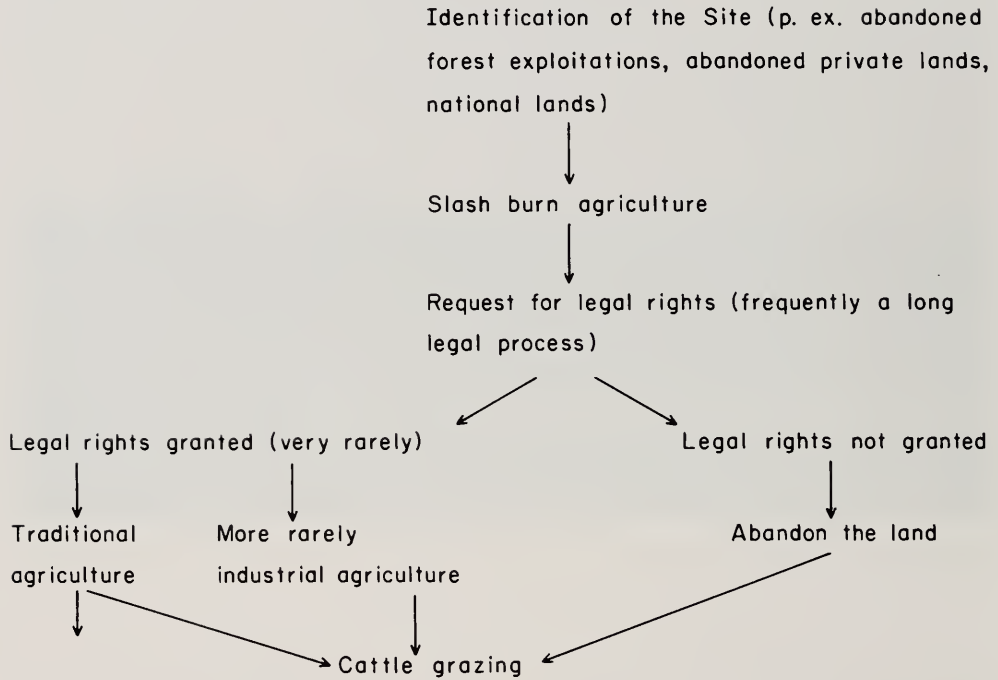


TABLE 2. Common steps in Spontaneous Colonization.

ses that can distinguish it are quite different. The most frequent means of this type of colonization is through the establishment of the “milpa” system of shifting cultivation (Fig. 2). The “milpa” techniques are the basic (and frequently the only) technology of subsistence farmers in the tropics of the world. Under conditions of isolation and low population density they form an excellent agro-forestry system. The system is well known, and several studies indicate that this system is the one best adapted to the ecological and economic conditions of the tropics (Denevan, 1981; Greenland, 1975; Hernández X., 1959; UNESCO, 1983).

When the farmers settle permanently in an area, the “milpa” system is rationalized (Fig. 3) and the farmers

look for the most adequate cycles for diminishing the pests and weeds and for the recovering of fertility. In this case the “milpa” system is often complemented with other farming systems creating an ecological mosaic of land uses. This may evolve into a land use management system based on the ecological mosaic of uses and resources. The Maya, for example, included managed successions, utilization of a great variety of plants and animals from their natural and managed ecosystems, forest plantations, a diverse variety of farming systems, and conservation of semi-managed natural forest areas (Gómez-Pompa et al. 1984, Gómez-Pompa, 1987).

Unfortunately the people who settle in abandoned areas of forest exploita-



Fig. 2. Shifting agriculture is the most important farming system in the tropical world since ancient times and the principal cause of temporal deforestation.



Fig. 3. The dooryard forest gardens of the Maya provide the clues to explain the abundance of useful tree species in the “natural” rainforests. They are empirical experiments in agroforestry designs.

TWO TYPES OF SHIFTING AGRICULTURE

<u>With legal rights to the land</u>	<u>Without legal rights</u>
Careful burning	Careless burning
Perennial crops planted	No perennial crops
Careful soil selection	No selection of soil
Search for optimal fallow	Disregard for the fallow
Protection of useful trees	No protection
Medium to long term planning	Short term planning

TABLE 3. Two types of shifting cultivators.

tion are “illegal” and their permanence is not secure. For that reason their activities do not include systems that will assure regeneration and conservation of the resources for the long term. Frequently the care for the milpa and for the surrounding forests is not the same as that of those who are assured of permanency in one place (Table 3). Often these spontaneous farmers are those responsible for burning large extensions of forest areas in the tropical lowlands of Mexico. This is opposed to the rational activities and excellent use of the milpa by many other farmers with stability on their land; an outstanding example is the case of the milpa of the Lacandone Maya (Nations & Nigh, 1978).

These are also some of the reasons for which “milpa” agriculture has been blamed for deforestation of the tropics, but in error. It would be equivalent to blaming the axes and bulldozers for the deforestation process. Shifting cultivators have survived since remote times and by trial and error have developed a great diversity of techniques, including permanent agriculture.

Clearly, the deforestation process is complex and requires detailed analysis of each situation.

However, in spite of all the preceding, there is a question which has not been discussed sufficiently, in spite of its importance. It concerns whether deforestation is really a problem and for whom.

THE DIFFERENT PERCEPTIONS OF DEFORESTATION. In spite of what is generally believed, shifting agriculture practiced by expert farmers in flat soils or with moderate slopes is not the cause of considerable erosion. Even in pronounced slopes in humid climates, erosion is minimal due to the short time in which the soil is exposed without plant cover (Sánchez, 1976).

The erosion of soils in areas of low scale forest exploitation in tropical regions with slight slopes also is not a problem, at least on a short term basis; except in cases in which heavy machines are used on a large scale. In a study made at IITA (International Institute of Tropical Agriculture in Ibadan, Nigeria) it was found that the erosion produced by using native Nigerian systems for felling the forest is nearly non-existent compared to that produced by bulldozers (Table 4).

Neither deforestation due to forest exploitation nor opening of new areas for agriculture and grazing (which is the same) represent a critical problem in the short term for farmers; on the contrary, they allow landless farmers to have new areas for growing crops and also create some temporary jobs in the clearing and extraction of wood. The same happens to small and large land owners with the additional advantage that they may obtain an additional economic reward as payment from the wood concessionaires as rights for the exploitation ("derechos de monte").

All of these short term economic effects have contributed to the belief that tropical forests are useless, and that they are waiting to be incorporated in the development of the countries.

Deforestation in the Mexican tropics also is not a serious problem for local or central governments. On the other hand, it is a short term solution to the

LAND CLEARING METHOD	EROSION LOSS (TONS/HA)
Traditional slash and burn	0.01
Bulldozer with shear blade	3.82
Bulldozer with tree pusher and root rake	19.57

TABLE 4. Effects of alternative land-clearing practices on soil erosion in an Alfisol from Nigeria (Source: Annual Report from IITA, 1980).

demand for jobs and land by the farmers. Clearing and exploitation of the forests are sources of large incomes due to taxes and, for some government officials, are a source of illicit income.

Deforestation also is not a problem for the private sector since even those more closely related to the problem, who may be the forest products entrepreneurs, have their investments (saw mills, etc.) assured by the return of the invested capital. Tropical forest products business is seen as a mining business and not as a renewable resource business. Investments are very low and returns quite high.

From this analysis you can see clearly the basis of the problem of deforestation in the tropics of Mexico. In the minds of the principal decision makers (landowners, business people, cattle ranchers, industrialists) the problem does not exist.

Deforestation in the tropics has been identified only by scientists of different biological disciplines, and by groups of citizens, mainly from industrial countries, concerned over environmental problems.

The only unquestionably important scientific argument that these groups propose is that the forests and other tropical ecosystems comprise a very important reservoir of species and genes, that form the most important biological bank of mankind (National Research Council, 1980; Soulé & Wilcox, 1980). It is also a fact that modern science knows very little about these species and there are still many of them to be discovered.

Unfortunately many of the arguments that have been used to stop the deforestation process have not been based on this important argument and other, more controversial arguments, have been used. This caused attention to be diverted toward other possible effects of deforestation such as the loss of soils by erosion, the low fertility of many tropical forest soils, the possible effects of tropical deforestation in the climatic patterns of the earth, and others of less importance.

The problem with diverting attention to these other arguments is that each of them requires a different explanation and frequently the arguments have not been convincing enough (Ewel, 1981; Lugo & Brown, 1981; Sánchez & Buol, 1975). This open discussion on controversial subjects is causing more problems, since decision makers have additional arguments for not acting.

If we accept this as true, then we must concentrate our efforts on looking for solutions to the only problem that is widely recognized; the genetic erosion produced by the loss of species and of biotypes (Soulé & Wilcox, 1980; Vovides & Gómez-Pompa, 1977).

If we admit that this is a worldwide priority problem (IUCN, 1980), the solutions are very obvious and easy to identify. Among them we can mention the following.

1. Required is an efficient system of conservation of biological diversity through a network of protected areas representative of the different regional ecosystems.
2. Required also are more biologically diversified agriculture and silviculture systems.
3. There is need for better directed activity in conservation ex-situ of some valuable species for the future.
4. Those production systems that use biological diversity as a basic strategy should be stimulated.
5. It is necessary to have a more aggressive worldwide campaign using only serious scientific arguments to inform and educate people of the importance of conserving the biotic patrimony of mankind.
6. The cost of conservation should be paid by all who benefit from it; i.e., all mankind, not only those who live in the area to be conserved.

To execute these solutions implies a profound change in the point of view that prevails now relative to the management and conservation of renewable resources of the tropics.

FORESTS AND SOIL EROSION. Loss of soil by deforestation and overgrazing has been mentioned as a critical problem especially on the slopes of tropical mountains and in arid and semiarid areas.

The same type of analysis could be made to understand the "problem" of soil erosion and water loss caused by deforestation. Many papers have been written on the importance of forest lands, on the protection of watersheds, and as measures to prevent the siltation of water bodies. In this case arguments related to the conservation of biological diversity have been used in favor of protecting the forests, instead of using the

proper arguments on soil erosion and water flow.

I will use a concrete case in the center of the State of Veracruz in Mexico that may help in understanding the problem and in finding feasible solutions.

According to the studies done in this region (Koterba & Olivieri, 1983), there are serious problems of erosion, mainly on the semiarid higher slopes (above 2500 m.) of the Cofre de Perote.

Studies on the erosion of the region give us amounts up to 1295 tons per Ha per year of soil loss and an average for the whole area of 40 tons per Ha per year (Raa & Espinoza, 1983). Erosion in this area is caused by deforestation and inadequate agricultural and grazing activities. These figures indicate clearly to us that there is a serious problem. Now, who is affected by the problem?

Those who cut the pine trees for opening new agricultural fields do not see the immediate problem since they sell the wood and have their crops. Those who cut the trees receive the profits from selling the wood. The poor farmers in the area find an important income (sometimes their only income) in doing this illegal cutting and selling of wood.

The farmers are in favor of deforestation for they have new soils to cultivate or a site to take their animals to graze. Erosion is not identified by them as a serious problem, at least for the short term, since they can use fertilizers for some of their most important cash crops and if the soil is lost, they can move to another site or emigrate to a different region.

The siltation of lakes, rivers and lagoons at lower altitudes caused by erosion is not identified as a problem by those supposedly affected—as are the inhabitants of the banks of rivers or la-

goons—by this influx of sediments. On the contrary some even acknowledge the importance of the sediments since they enrich the bodies of water with nutrients, and in areas affected by periodic floods, they also enrich their agricultural fields. The process of silting is slow in human terms, therefore it is not identified as a real problem.

For these reasons the few successful reforestation projects in the high erodable areas of the Cofre de Perote are not done in an attempt to control erosion but as profitable competitive activities (for example, fruit tree plantations).

Neither deforestation nor erosion in the area is a problem for the shepherds. The clearing of the forest and the opening of new agricultural soils and their eventual abandonment are actions that produce new and better areas for grazing.

The private industrial entrepreneurs do not identify deforestation and erosion as a problem that could affect them, since there are no permanent forest industries in the area. Erosion is not identified as a serious problem for other industries in the region.

In contrast with these perceptions, deforestation of the Cofre de Perote has been identified as a problem by groups of urban citizens from nearby lower localities that blame deforestation as the cause for the water shortages in the cities and for the reduction of water in some springs of the area. They also impute deforestation to be the cause of "climatic changes" in the region. It is clear that these two problems are practically nonexistent, the first could be solved by having better water catchment structures and better distribution networks for urban villages, and the one referred to climate is a misunderstanding that has been spread throughout all Mexico and which lacks scientific basis.

In addition to this, it is known that deforestation increases the height of the water table in most of the cases that have been studied, with the possible exception of cloud forests, for its role in capturing precipitation and adding it to the water budget of the system (Hamilton & King, 1983).

Erosion caused by deforestation has also been identified as an environmental problem for the medium and long term by scientists working in the area (Golberg, 1983), especially since cloud forests of different types occur in the region.

These two groups of citizens (urbanites and scientists) provoke a different type of problem for the local and federal government officials, since they constitute an important citizen group of great influence over public opinion. This fact turns the deforestation problem into a political one. It is interesting to mention that deforestation, water shortages and erosion are popular subjects in the political discourse. If we add the fact that a large portion of the Cofre de Perote is a National Park, the situation becomes even more complicated.

These conflicting perceptions of the problem by different groups explain the failure of the very many reforestation (per-se) programs for the area, that are periodically proposed by state or national forest authorities, but that never have an echo from the inhabitants of the deforested sites.

As we can see from this case, the perception of different sectors of society on the role that forests play in the protection of the renewable natural resources, varies a lot within one region.

In this case one may also see the usefulness of analyzing the problem in order to find possible solutions.

It is clear that there is a great confusion and a lack of reliable information.

Nevertheless, with the little existing data it is possible to identify concrete actions and the parties responsible for their execution.

As an example, I will mention some possible actions to be taken in this case.

SOME SOLUTIONS TO THE PROBLEM OF EROSION. The corrective actions should be: (1) the establishment of perennial crops on steep slopes, especially as buffer zones (tree belts) along water courses, and (2) the construction of terraces or other erosion control techniques. It will be necessary at the same time to stimulate conservation methods for sustained exploitation of the remaining forests or substitute them for tree plantations including agro-forestry systems. These corrective actions need investments, but those directly responsible (forest exploiters, farmers, cattle raisers) do not identify deforestation and erosion as their problem. They also lack the capital for carrying out the protective measures mentioned above. A completely different approach through economic incentives (low interest loans, subsidies, etc.) will be needed to accomplish the necessary actions. At the same time it will be necessary to have the appropriate legislation to regulate the use of land based on ecological, economic and agro-forestry studies in addition to the informed opinion of all people involved. But maybe the most important thing that will be needed is an efficient program of education, including an education extension program, for the region.

PROBLEM OF PROTECTION OF FLORA AND FAUNA. With the above suggested actions a large part of the biotic resources of the area may be better used and protected. In addition to this, it will be useful to revise the original Decree of the National Park of the Cofre de Perote and to make the necessary

changes to adapt it to the realities of the area.

Other actions from the State and Municipal Governments and also of private organizations to protect the biotic resources of the region should be stimulated.

As you can see, the solutions for each individual problem are not difficult to understand since they are so obvious. The implementation of the solutions is the limiting factor since all of them will affect economic interests and also will require considerable investments. The consequence of this is that nothing is done and deforestation and erosion continue. This attitude prevails for the region and for most of Mexico. And this is the reason for ever increasing deforested, erodable landscapes that occur in so many tropical regions.

FARMERS AND THE PROTECTION OF RESOURCES. Another important part of our analysis should be directed to the most important sector of the rural areas: the farmers living in them. Frequently development programs in the tropics are formulated in such a way that it seems as if the areas were uninhabited, when this is not the case. The tropical areas of low altitude in Mexico are inhabited by farmers, including the most remote ones. The tropical lowland areas, for example, of the Maya area have been inhabited continuously for over 3,000 years (Hammond, 1982).

It is clear that the perception of the farmer of forest exploitation, reforestation, use and management of their natural ecosystems, as well as their systems of agricultural production are often completely different from those of modern industrial society.

I will use the case of the Maya area to exemplify the importance of taking into account the traditional cultures to

resolve some of the present problems in the management of the forest resources in the tropics.

MAYA SILVICULTURE. In the past few years several publications on the subsistence system of the old Maya have appeared (Darch, 1983; Flannery, 1982; Gómez-Pompa & Golley, 1981; Harrison & Turner, 1978; Turner & Harrison, 1983).

However the use of the tropical forests and the forest resources by the present and ancient Maya is a subject that has not been studied well, in spite of the enormous importance it has in the possible design of better systems for the management of the resources in the area (Barrera M. et al., 1977).

Unfortunately, ignoring the local inhabitants in developing programs for the tropics is a very widespread attitude.

The present day Maya and probably their ancestors use forest successions as a key technique in agriculture and silviculture. Plant and animal resources from successional fallows are very important in the subsistence economy of the present population of farmers, for they obtain firewood, wood, fruits, medicines, game, and materials for construction. With the management of secondary vegetation they obtain the recuperation of the fertility of their soils and control of their weeds and pests.

A very important fact to point out is that the knowledge of the value of biotic resources of the present Maya comes from their remote ancestors.

Unfortunately this appreciation tends to be forgotten due to the arrival of substitute products resulting from the modern industrial sector such as plastics, fertilizers, asphalt sheets, canned products, and registered medicines among others.

In spite of this cultural pressure in the Maya area there has been a strong

resistance that has allowed the survival of many uses and techniques coming from the ancient Maya. Some of them are about to disappear and perhaps many others have already done so.

On the other hand, it was once believed that the ancient Maya were important arboriculturists and silviculturists (Gómez-Pompa et al., 1984; Gómez-Pompa, 1987). It seems that the tropical forests had a greater importance for them. They depended on the forests for their subsistence and it seems that they were aware of their great potential.

Many of their basic products came from their forest ecosystems. The seeds of a forest tree of the Maya area, *Brosimum alicastrum*, provided them with an additional subsistence grain which probably was used as a complement to corn or a substitute for it in dry periods. The importance of this tree was mentioned by Puleston who suggested that this species was a fundamental resource that explains the success of the Maya culture in the past (Puleston, 1982). The same can be said for other wild fruit tree species of the tropical forest of the Maya such as: *Acrocomia mexicana*, *Annona squamosa*, *A. purpurea*, *A. muricata*, *A. reticulata*, *Byrsonima crassifolia*, *B. bucidifolia*, *Calocarpum mammosum*, *Casimiroa edulis*, *Chrysophyllum cainito*, *Cordia dodecandra*, *Crescentia cujete*, *Diospyros digyna*, *Leucaena leucocephala*, *Lonchocarpus violaceus*, *Manilkara zapota*, *Parmentiera edulis*, *Persea americana*, *Pithecellobium dulce*, *Pouteria campechiana*, *Psidium guajava*, *Spondias mombin*, *S. purpurea*, *Talisia olivaeformis*.

Some authors in the past (Lundell, 1937; Puleston, 1968) suggested the possibility that the tropical forests of the Maya area with their abundance of useful species were certainly managed by the ancient Maya.

According to the studies on this subject, I believe that the forests we have at the present in most of the Maya area are the result of an ancient and complex tropical silviculture, developed by the ancient inhabitants of this region.

This hypothetical Maya silviculture (Gómez-Pompa, 1985b) consisted of a set of techniques integrated with their agricultural activities to cultivate, protect, and select tree species of economic, ecological, or cultural interest in all the region. It included the cultivation of a high number of trees in the backyards of their houses and ceremonial centers, in their forests and successions, and in special sites near their milpas, where they had forest gardens like the "petkot" (Gómez-Pompa et al., 1987).

The protection of useful trees in the slash and fall of the forests for their milpa cultivation was an important technique. The selection and protection of useful species (in the form of "stumps") that coppice during the slash was also an important technique. In addition the planting of trees in the milpas and their surroundings contributed to the presence of a useful forest flora. The protection and cultivation of trees and shrubs in the vegetation belt that protects the milpas (including the "guardaraya") also plays an important role in the tree management of the Maya. An important part of this silvicultural system is the management of their "natural" forests through selection and enrichment, by planting useful species. The Maya of today as well as their ancestors observed and experimented with their wild biota discovering uses for most of the plant species. Those of greater value were probably semi-domesticated in their dooryard gardens.

These combined techniques provided them with abundant forest products for their subsistence and at the

same time biological diversity was preserved. The activities of biological conservation of the Maya were mainly a matter of practical survival, mixed with superstitions and other beliefs.

The possibility that the old Maya gave value to the conservation of biological diversity can not be disregarded, mainly if we take into consideration the precise knowledge they had of their wild biota shown in the rich biological nomenclature of their folk taxonomy (Barrera M. et al., 1976) and in the vast knowledge of the possible uses of practically all their flora (Mendieta & Amo, 1981; Roys, 1931).

The present Maya, inheritors of this technology, have given us the clues to reconstruct the silviculture since they still have many of the ancient practices, although not integrated in any one place.

The dooryard gardens where several "wild" species including the famous "ramón" (*Brosimum alicastrum*) mentioned before are cultivated and protected, are a good example (Smith & Cameron, 1977).

The tropical forests of the Maya area, that are being deforested in colonization projects and in forest exploitations that have been going on for decades, are the product of an advanced ancient silviculture of the old Maya.

Unfortunately the present day Maya farmers, inheritors of that silviculture, which in part they still preserve, cannot use those techniques and methodology since the modern industrial society requires the trees of their ancient "selvas huerto" (forest gardens) for their industries, and the soils for grazing lands. And probably in the future they will dedicate them to nonspecific forest plantations. What incongruency!

Obviously, we have before us two different cultures, the traditional (past

and present) and the modern industrial one, each with different values and perceptions of the importance, use, and conservation of the forest resources. It is clear that if we want to make a change in the present tendencies we will have to consider the two worlds and try to make compatible the conflicts of interest and of values.

It is evident too, who has the responsibility of being aware and taking the first steps.

SOME FINAL CONSIDERATIONS. Due to all I have mentioned before, it becomes quite clear that a profound change is needed in our approach to the problem of deforestation in countries where these two cultural worlds co-exist.

The present approach of ignoring traditional methods of management of resources seems to me erroneous, as erroneous as it is to try to impose new and often inefficient methods. These mistakes have led us to a considerable loss of tropical forest resources that endanger the biological heritage of the tropics.

I suggest that the plans and programs for forest development in countries where fortunately the two cultures coexist, should foresee different actions and approaches for the two realities. The approach and objectives of forest research, education, extension and development should be adapted to the two cultural worlds. The human and economic resources should be equally invested in the development and technological improvement of both approaches.

The first approach should correspond to what I call Maya Silviculture, and be oriented toward the improvement and gradual intensification of the traditional silvicultural practices with techniques either traditional or modern,

including low investment and intensive hand labor. Examples of activities that are suggested for the support of this approach would be:

1. The study and selection of protected species in the felling process. This selection would be made in direct contact with the local communities and according to their needs.
2. The study and selection of useful tree and shrub species of rapid growth that can be selected and protected. The selection can be made in relation to their direct use such as food, construction, medicine, etc; or through their role in the fallow; or for their advantages as green manure or for the quality of the nutrients in ashes for the next milpa.
3. The selection of forest species and a mixture of them that could be planted during the agriculture seedling to establish an artificial forest (for example the Taungya-system).
4. Protection and development of small forest areas like the Maya "pet-kot" and the Huastec "te lom" (Alcorn, 1984) near the milpa.
5. Study on optimization of architectural designs and production in dooryard gardens, also on mechanisms for industrializing and commercializing their products.
6. Selections and improvements of tree species in the dooryard gardens (Fig. 3) according to local needs and possible markets.
7. Development of small forest units (managed tropical forests) based on the management of natural tropical forests.
8. Study of the local agroforestry systems to evaluate their economic and ecological efficiency and to suggest improvements to them (for example, study of the wild Leguminosae used

as shade in coffee and cacao plantations, etc.).

9. The evaluation of modern technical advances and their possible adaptation to Maya Silviculture.

This point of view on silviculture should include as an indispensable part, the formation of professionals, technicians, extensionists, researchers and promoters who would have as a main focus of their education this approach in addition to modern silviculture and ecology.

The other approach would be the one for the industrial silviculture which would be directed mainly toward forest plantations to supply the demand of industries. Its main land competitor will be commercial agriculture and cattle raising activities.

The main problems that last approach will have to face would be:

1. The problem of long term investments in poor countries.
2. The low profitability of short and medium term of forest plantations in comparison with other agricultural and cattle raising activities.
3. The need for large areas generating conflicts with the urgent need of land for landless farmers.
4. The problem of pests and weeds, inherent to all monocultures, especially in the tropics.

This dual system of forest research and development that I propose may be an alternative solution to the deforestation problem of the tropics and also an alternative tool for a more realistic and ecologically sound development for many underdeveloped regions of the world. An example of the possibilities of this approach can be found in the interesting work that recently has been done in tropical agriculture at the IITA

(International Institute of Tropical Agriculture in Nigeria) in the study and development of new farming systems based on traditional techniques (Wilson & Kang, 1981) and also those of the IRRI (International Rice Research Institute in the Philippines) on traditional farming systems. I must not forget to mention the contributions from my own institution, INIREB (National Research Institute of Biotic Resources in Mexico), on the study of the traditional "chinampa" agriculture and its transference to the tropics (Gómez-Pompa et al., 1982).

To end, I must repeat that the natural forest ecosystems in the tropics are in great danger. The problem has been mentioned and analyzed over and over again in many forums. It is time to follow a more aggressive and realistic approach in tropical forestry and in this approach the ancient Maya Silviculture may help us to see the future.

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