AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
BATCH #16

1. SUBJECT CLASSIFICATION

A. PRIMARY
Agriculture

AE10-0000-G302

B. SECONDARY
Agricultural economics--Latin America

2. TITLE AND SUBTITLE
The nature of shifting cultivation in Latin America

3. AUTHOR(S)
Haney,E.B.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1968	31p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Wis.

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*
(In Land Tenure Center paper no.45)

9. ABSTRACT

10. CONTROL NUMBER
PN-RAA- 812

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Cropping patterns
Cultivation
Latin America
Shifting cultivation

13. PROJECT NUMBER

14. CONTRACT NUMBER
Repas-3 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Bepac-3

LTC P

May 1968

LTC No. 45

THE LAND TENURE CENTER
310 King Hall
University of Wisconsin
Madison, Wisconsin 53706

THE NATURE OF SHIFTING CULTIVATION IN LATIN AMERICA

by

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All views, interpretations, recommendations, and conclusions expressed in this paper are those of the author and not necessarily those of the Land Tenure Center.

THE NATURE OF SHIFTING CULTIVATION IN LATIN AMERICA*

by

Emil B. Haney, Jr.

For centuries, the practice of shifting cultivation in its variant forms has been the predominant system of land utilization among tropical agriculturalists. Only in the relatively recent past has there been a wholesale introduction of more intensive methods of land utilization into the tropical regions by colonial powers. The FAO staff estimated that over 200 million people, dispersed over 14 million square miles of tropical territory, still derive the bulk of their food by shifting cultivation. That is to say, these people, representing about 10 percent of the world's population, are spread over more than 30 percent of its exploitable soils. The five million square miles of tropical America support about 65 million people (Nye and Greenland, 1960). Most of the agriculture in this vast expanse of territory is some form of shifting cultivation. (See Figure 1.)

Anthropologists, geographers, pedologists, and other scientists have pointed out the shortcomings of shifting cultivation as the basis for a stable agrarian society. Nevertheless, this system continues to be perpetuated over most of the humid tropics in lieu of more advanced systems of land utilization. Such a primitive and yet complex ecological arrangement cannot be readily cast aside in exchange for temperate cultivation schemes. A more reasonable approach to expanding the food production potential of the extensive tropics undoubtedly begins with a scientific understanding of the physical, biological, and cultural milieu. Gourou (1958) expressed this view in the following manner:

> The disasters brought on by agricultural methods which have taken no account of the treasures of wisdom and experience accumulated in the old tropical system are a sufficient proof of the latter's value.

The ensuing presentation will be an attempt to consolidate some of the "treasures of wisdom and experience" which have been revealed by numerous scientists devoted to the problems of shifting cultivation. This account will give special treatment to the tropical areas of Latin America. If any geographical region suffers from the paucity of research on shifting cultivation, it is tropical America. In recognition of this negligence, clearly revealed in the classical bibliography compiled by Conklin (1961), the FAO has appointed R.F. Watters to initiate basic studies on shifting cultivation in Latin America.

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*This paper was originally presented to the Department of Soils, University of Wisconsin, August, 1964. The present version is revised.

Introduction

Concepts of Shifting Cultivation

Shifting cultivation exhibits remarkably similar characteristics in all parts of the tropical world. Anthropologists and other investigators have encountered a whole array of nomenclature meaning essentially the same thing, that is, the custom of cultivating scattered clearings in the reservoir of natural vegetation, abandoning them when the soil becomes exhausted, and perhaps shifting homesteads in order to follow the search for new fertile land (FAO, 1957). Terminology commonly employed by the various writers on the subject includes: ray (East Indo-China), caingin (Philippines), milpa and coamile (Mexico), conuco (Venezuela) roza and monte (Colombia) chacra (Peru), roça (Brazil), ladang (Java) and masole (Belgium). Ekwall (1955) the eminent Swedish authority on the English language, suggested the word "swidden," to mean shifting cultivation because of its relation to numerous Scandanavian terms having related meanings. U.S. writers, however, have generally accepted the term "shifting cultivation."

Perhaps the most functional definition of shifting cultivation in the literature is that set forth by Pelzer (1958):

> Shifting field agriculture is characterized by a rotation of fields rather than of crops, by short periods of cropping (usually one to three years) alternating with long fallow periods (up to 20 years or more, but often as short as six to eight years), by clearing by means of slash and burn, and by using the hoe or digging stick, the plow only rarely being employed.

While the most primitive form of shifting cultivation exists in sparsely populated tropical forests, where the farming of cultivated clearings by family groups represents only a slight step beyond the hunting and fishing stage, more developed communities live in fixed villages and farm the surrounding land in a somewhat erratic land rotation system. In the latter situation, soil depletion does not lead to immediate migration, but rather to the cultivation of plots farther away from the center. Consequently, the fixity of villages usually leads to a more rapid destruction of the renewable natural resource base.

Watters (1960) suggests a classification system for shifting cultivation which is based primarily on the differences in the economies with respect to the means of food production:

1. predominantly hunters and gatherers, but practicing shifting cultivation to a small extent;

2. depending mainly on shifting cultivation, although engaging in some hunting, fishing, or gathering;

3. depending almost entirely on shifting cultivation, with almost no other source of food production;

4. predominantly pastoralists, but also practicing shifting cultivation;

5. depending mainly on shifting cultivation with some pastoralism;

6. depending mainly on shifting cultivation, but with some sedentary agriculture;

7. some shifting cultivation, some permanent cultivation, with some pastoralism;

8. predominantly some form of permanent agriculture with some shifting cultivation.

Popenoe (1964) sees shifting cultivation as only one of several alternative forms which pre-industrial, tropical agriculture may take. He lists four different types--garden, fire (including shifting cultivation), irrigation, and terrace agriculture. All of these require manipulation of the environment, such as clearing, burning, control of moisture, or modification of the topography. Increasing population pressure and rising standards of living gradually force more intensive systems of land utilization. Moreover, Popenoe maintains, it is only through the adoption of these improved systems, especially irrigation agriculture, that modern societies can evolve. An example in support of this position would be the rather elaborate agricultural systems in many of the superpopulated tropical areas of Southeast Asia.

The Tropical Setting

Pendleton (1950) and many others have attempted to change some of the erroneous popular opinions held by people of the temperate regions in regard to the agricultural potential of the tropics. Pendleton reasons that the rapid decline in the productivity of tropical soils results from the fact that practically all of the plant nutrients within reach of the forest trees have been taken up by the growing vegetation. Moreover, almost all of the plant offal (dead leaves, twigs, fruit, fallen trees, etc.) which falls to the ground is quickly attacked by termites and decay organisms, and thus the minerals are rapidly re-incorporated into the phytocycling process. When the forest is cut and burned this cycle is broken and the plant nutrients are released in a soluble form in the ash. But before the crops (maize, beans, manioc, plantains) can absorb any considerable proportion of these liberated nutrients most of the soluble materials are leached deeply into the subsoil by the frequent rains. Woody plants and, in particular, large forest trees, have the capacity to assimilate greater

amounts of nutrients per hectare than grasses and annual crops (Kellogg 1963). It is for this reason, plus the fact that grasses in the tropics are usually subject to annual or periodic burning, that forest soils tend to be more productive than savannah soils in the tropics. Thus the axiom of the temperate regions, that grasses are the soil builders, must be reversed for the tropics.

The soils of the tropics are predominantly latosols (Taylor 1962). Their special characteristics include reddish coloration, high acidity, a stable micro-aggregation, and a clay fraction composed chiefly of kaolinitic minerals with iron and aluminum oxides (Nye and Greenland 1960). The latter authors recognize an important division among the latosols: soils showing characteristics of excessive leaching (Oxisols), and those less thoroughly leached (Ochrosols). In addition, a distinction may be made between the forest soils and the savannah soils, the latter tending to be more highly leached.

Other features of the tropical setting which have a bearing upon shifting cultivation include the climatic conditions. Hot temperatures with little daily or seasonal variation prevail throughout the tropical areas. Rainfall tends to be concentrated in one or two seasons of the year intermingled with pronounced dry seasons. Such a pattern of wet and dry seasons exerts a very strong influence upon the shifting cultivation pattern. For example, in the Chocó region of Colombia where the annual rainfall averages more than 300 inches and there is no pronounced dry period, a variation of shifting cultivation described as "slash-mulch" is practiced (West 1957). Since fire cannot be employed because of the continually-drenched jungle, the seeds are broadcast, or the rhizomes and cuttings are planted in an uncleared plot, and then the bush is slashed. Decomposition occurs rapidly, forming a thick mulch through which sprouts from seeds and cuttings appear within a week to ten days. This practice has also been reported in the wet Cordillera de Talamanca in Costa Rica.

General Characteristics of Shifting Cultivation

Some Universal Aspects

Except for local adjustments to specific ecological, technical, and economic conditions, shifting cultivation is remarkably similar in all parts of the tropical world. The persistence with which natives of the tropics adhere to shifting cultivation techniques, even in the face of administrative disincentives put forth by colonial governments (as in most parts of Southeast Asia), is equally striking (Leach 1959). Furthermore, in cases where a few colonists of a higher culture have gone into countries of a primitive culture, the tendency is for them to gradually adopt shifting cultivation (Bartlett 1951). Waibel (1948) describes the case of the German settlers in Espirito Santo, Brazil, who initiated temperate agricultural practices, only to

give them up for the native Brazilian form of shifting cultivation after several years.

The viability of this system in the absence of over-population may be attributed to a number of factors. Fals Borda (1957) suggests that farmers use this system primarily because they do not have a more convenient way of clearing trees and dense vegetation from the land, and they lack the means and knowledge of maintaining soil fertility in any other manner. Blaut (1959) argues that shifting cultivation is the most intensive form of agriculture possible in most humid tropical slopeland because of the rapid leaching of nutrients in these soils, the immobilization of the larger part of the nutrient supply in plant tissues, and the difficulty of controlling erosion.

Causes of Shifting Cultivation

There are two schools of thought which attempt to explain the causes of shifting cultivation--the environmental approach and the cultural approach. The former school has been supported by Gourou, Waibel, Pelzer, and others who use the argument that climatic conditions--particularly high temperatures and high rainfall--soil conditions, vegetation, and topography largely dictate the land utilization pattern. This environmental argument has been supported by the FAO (1957): "Shifting cultivation has assumed various forms in different regions, chiefly in response to varying physical factors, particularly rainfall." This study concluded that tropical areas with a rainy season of two to four months remain mostly under grass and support nomadic cattle-owning tribes; land receiving four to six months of rain usually has open woodland in which shifting cultivation is frequently practiced; and, if the rainy season is greater than six months, the land remains predominantly under forest vegetation. In addition to the rainfall factor, the FAO study emphasizes that the rapidity with which tropical soils lose their fertility and undergo undesirable physical changes encourages the development of an agricultural system based on shifting cultivation. In particular, these processes of degradation include a lowering of the absorption capacity for exchangeable bases of the clay fraction, a tendency for the clays to immobilize phosphates, leaching of the porous soils by the heavy tropical rains, and a rapid destruction of organic matter by bacterial action under the high temperatures.

A few writers on the subject of shifting cultivation tend to lay greater emphasis upon the cultural aspects. Gourou (1951) wrote: "As with all agricultural techniques, ladang (meaning shifting cultivation in general) is the expression of a civilizational level and not the result of any inescapable physical constraint." He asserts that the poverty of tropical soils owing to their lack of resistance to leaching and erosion does not necessarily favor shifting cultivation more than other agricultural systems. The author further suggests that human choices are influenced much more by the level of techniques than by

physical conditions. In support of this argument, the Mayan civilization is offered as an example. Shifting cultivation formed the economic base of this empire, but the soils of the Central Petén region of Guatemala, the center of the Mayan culture, happen to be rendzinas. And, these limestone-derived soils are generally included among the best soils in the tropics because of their relatively high pH values and cation exchange capacities.

Blaut (1959) observes that few shifting cultivation groups in the areas of tropical slopeland have adopted a more intensive land utilization scheme in the absence of outside pressure or its indirect effects, such as over-population. He suggests that the change from intensive agriculture to shifting cultivation, as in the case of the Europeans in Brazil, occurred because the yields per unit of labor are higher under shifting cultivation if there is no quantitative constraint on land resources. In further support of this argument, he notes that in parts of the West Indies, farmers work marginal land by shifting cultivation and their own land by sedentary means. If marginal land is available, a farmer will rent it and farm it for a year or two and then abandon it for another plot while the original piece of land lies in fallow.

Watters (1960) states that the societies practicing shifting cultivation in the humid tropics are "characteristically undeveloped and represent a low cultural level," but he maintains that "the cultural and environmental effects are inseparable." Blaut (1959) concludes that shifting cultivation in the tropics is not the "natural" form of these areas, nor do such physical environments constitute a "specific agricultural potentiality" allowing no more intensive system than shifting cultivation. He reasons that the uniformity of shifting cultivation in the tropical forest areas of South America derives from a "cultural-ecological pattern," and not from a special variety of environment. De Haan (1959) lists several factors determining shifting cultivation--the natural environment, demographic, economic, and social conditions; but he believes that the demographic factor is the most decisive one. He describes an area of shifting cultivation as one in which the economy is local, isolated, and self-dependent. Since the production of a surplus is, in most cases, beyond the requirements of subsistence, there is little incentive for producing beyond the basic needs. In other words, the invididual is subordinated to the community.

A recent report bears out, in a convincing manner, the inseparability of environmental and cultural aspects. Conklin (1961) writes that the specific form of shifting cultivation in a given geographical or cultural province depends on:

1. extent of available land, labor, and capital;

2. local settlement pattern;

3. degree of social and political integration with other segments of the larger society;

4. agronomic variables, including kinds of principal crpps produced, types of principal crop associations and successions, crop-fallow time ratios, dispersal of shifting cultivation plots, presence of livestock, use of specified tools and techniques including soil treatments, vegetal cover of the land cleared, climate, soil conditions, and topography.

Phases of Shifting Cultivation

In general, seven distinct phases of shifting cultivation systems can be described. These are: (1) selection of the site, (2) clearing of the land, (3) burning of the slash, (4) planting, (5) weeding, (6) harvesting, and (7) fallowing. Local factors would tend to amend this list somewhat, but by and large, these phases are universal. A prime example of local modification would be the case of the Colombian Chocó region described earlier. In this situation, the heavy rainfall and the absence of a dry period result in the reversing of the order of the clearing and planting phases and elimination of the burning phase.

Selection of the site. The selection of a site for shifting cultivation is usually based upon the recognition of certain trees and other types of vegetation as indicators of soil capabilities (Watters 1960). In some cases other soil factors such as color, texture, and drainage characteristics become the guidelines for site location. Undoubtedly, economic, social, and political factors bear heavily upon the choice in some areas. Where the population pressure is great, the alternative sites are necessarily limited. Stationary or fixed villages usually mean that good sites are likely to be quite distant. Finally, in many cases, the local or tribal governments regulate very strictly, the use of the land under their jurisdiction.

Clearing the site. The clearing operation for new land generally begins late in the wet season or early in the dry season. For land which is to be planted for two or more successive years, clearing is usually done toward the end of the dry season. In the latter case, less time is needed for permitting the residues to dry before burning, and a regrowth of weeds is likely if the clearing is done too much in advance of the planting season. In clearing new land it is customary to fell the trees at waist height or more, since the trees of the humid tropics usually have buttresses which spread out at their bases. Axes are used for felling the larger trees, whereas the machete is the major implement employed for clearing the smaller vegetation. It is common to leave a few of the largest trees standing in the site, although they are sometimes girdled (Gourou 1958). Aside from the fact that these

trees may be difficult to fell with crude tools and would occupy considerable space on the ground if felled, they apparently provide the necessary shade for some crops, add stability to the soil, and serve as seed trees when the land is returned to fallow. The sizes of the plots cleared vary considerably, but they are probably influenced by the population density, the number of people to feed, the fertility of the soil, the ease of clearing, and the size and the energy of the available labor force (Watters 1960).

Burning. The burning of the slash in the shifting cultivation plots is normally done late in the dry season in order to permit the slash to dry as much as possible and to safeguard against the recurrence of weeds and tree sprouts. Occasionally, secondary and tertiary burnings are necessary (Watters 1960). The burning operation provides a practical means by which the vegetal residue is reduced largely to charcoal and ashes, which contain a readily available supply of plant nutrients. According to Laudelout (1960), the initial effects of burning the forest fallow include:

1. a temporary increase in the soil temperature during the burning process and a permanent increase in the average temperature of the soil because of the removal of the forest cover;

2. the addition of large amounts of charcoal to the upper layers of the soil and a charring of the organic horizons;

3. the liberation of a fraction of the mineral immobilization of of the fallow in the form of soluble salts, the rest of the mineral potential being volatilized, or remaining in an insoluble form in the woodashes or the unburned trunks and branches.

In more technical terms, Nye and Greenland (1960) specify the following effects of burning:

1. Large quantities of nutrients from the standing vegetation and litter layer are spread in the ash on the soil surface in the form of carbonates, phosphates, and silicates of the cations. However, nearly all the nitrogen and sulfur escape to the atmosphere in gaseous forms.

2. The immediate soil surface is heated, thus producing a direct effect on the microbiological, physical, and chemical aspects of the soil.

3. The changes in pH and nutrient availability may result in a very different microflora population.

Experiments at Chinchiná, Colombia, have revealed that burning may be advantageous to a certain point (Saldarriaga 1956; Suárez de Castro 1957). The burned plots yielded a significantly higher production than

the unburned plots, and double burning yielded more than single burning. This phenomenon was explained by the fact that burning incorporates large quantities of phosphorous necessary for plant growth, improves the soil structure and permeability, and does not radically affect the soil micro-organisms. In Brazil, experiments have indicated that the burning of abundant plant residues has a positive effect on wheat yields, while early plowing under of the vegetal residue, even with the application of 200 kilograms per hectare of $NaNO_3$, produced no significant yield increases (Baldanzi 1960). Gourou (1958) reports that between 600 and 900 pounds of nitrogen per acre are volatilized during the burning process. He suggests that burning is economically superior to other means and that it produces a mellowing effect on the soil, making tillage unnecessary.

Planting. Quite often, the planting operation begins on the opposite side of a shifting cultivation plot before the entire parcel has been consumed by fire. This operation generally takes place immediately preceding the rainy season or during its incipient stages. The planting is usually done with a crudely fashioned "digging stick." The seeds or tubers are dropped into the ashy layer and the surface soil without any further preparation of the soil after burning. In the more humid regions of Latin America, manioc is a favorite staple produced in the shifting cultivation plots, but in the drier regions, maize tends to be the predominant staple (Whittlesey 1937). However, it is not at all uncommon to see maize planted in combination with upland rice. The earlier maturing maize crop is retained primarily for subsistence needs whereas much of the rice crop may be sold. In Central America, maize, beans, and squashes are often grown in combination. The mixture of crops is even greater in the more humid areas of Colombia where maize, upland rice, manioc, and plantains are frequently interplanted. This provides a continual succession of crops until the native vegetation is permitted to succeed the plantains.

Weeding. Generally, little or no cultivation, in the strict sense of the word, is done on the plots, but one or two systematic weedings during the growing season are common. This is done with a machete, hoe, or by hand. Typically, the shifting cultivators wait until after the heavy rains have fallen before doing any weeding. This procedure eliminates the weeds before the dry weather and provides a mulch. But frequently the weeds are as high or higher than the crop by this time and some of them have produced seed. Most evidence points to the fact that weed competition becomes successively worse after the first year of cultivation.

Fallowing. Once the land is abandoned, the natural vegetation, as a rule, passes through several successions; but rarely is the climax ever reached before the land is cleared again (Nye and Greenland 1960). Since most fallows consist of a mixture of tree species, and consequently a wide variety of rooting habits, the nutrient absorption may be considerable (Kellogg 1963). The length of the fallow period depends upon

the density of the local population, the amount of land available for shifting cultivation, the vigor of the secondary growth, and its ability to eliminate undesirable species, especially grasses. A shortening of the fallow periods brought about by increased population pressure may lead to irreversible soil degradation. See Table 1.

Table 1.* Vegetative Matter and Plant Nutrients in Secondary Forest Vegetation (Congo).

Age in Years	Total Weight of Dry Matter per Hectare	Nutrients		
		N	P	K
		kilograms per hectare		
2	20	190	22	169
5	112	570	32	420
8	153	580	35	670
18	175	700	108	820

*F.A.O. Agriculture Study No. 43. Rome (1958), p. 160.

Laudelout (1960) suggests that the critical points where irreversible destruction is likely to occur may be determined by: (1) the cultivable percentage of the total area (rarely more than 75 percent), and (2) the estimated minimum length of the fallow period (rarely less than 12 years). He estimates that under normal conditions of shifting cultivation, irreversible degradation is likely to occur if the population density exceeds 25 persons per square kilometer (65 per square mile). Nye and Greenland (1960) state that shifting cultivation culture remains fairly stable as long as the population remains under 20 persons per square mile.

The Limitations of Shifting Cultivation

Demographic Relationships

While it is obvious that shifting cultivation must give way to more intensive forms of land utilization in the face of surmounting population pressures, the limits of toleration are far from being clearly defined. The FAO Staff (1957) expresses the opinion that where shifting cultivation has become systematized, as with the "corridor system" of the Congo, much higher population densities can be tolerated. Under such an improved system, they would set the population limit at 50 persons per square kilometer (130 per square mile). Above this population density, the use of fertilizers and other practices would be mandatory. Thus, if the demographic argument were the only issue of concern, many countries might reduce their problems by luring their excess population into the tropical rain forests. For example, fewer

than two million people occupy the approximately two million square mile Amazon Basin. On the other hand, the existence of sparsely populated rain forests in many Latin American countries has fostered careless colonization policies in lieu of land reform programs in the more densely settled areas of these countries.

Where the land is forced to carry more population than it can support under shifting cultivation, a rapid disappearance of the forest in favor of grassland savannah ("derived savannah" maintained by annual burning) is likely to occur (Nye and Greenland 1960). Moreover, where the population is so dense that all the climax rain forest is cut over before the older cuttings have rejuvenated, the people must devote extra labor to clearing the tangled regrowth. This may force them to keep the land in cultivation for longer periods and thus accelerate the depletion of the soils to an even greater extent. Of course, one may argue that the added task of clearing the thickets may be handled by the increased number of available workers.

Socio-economic Constraints

The decreased productivity of labor implied in the foregoing discussion may lead to the problem of providing only enough food to support the population. In the forested mountain country in the eastern part of Guatemala, it has been estimated that each Indian family requires from 100 to 200 acres of land just to maintain a subsistence level (Whittlesey 1937). Depending on the type of land and the subsistence needs, one family will work up to ten acres of land in any given season. Now, the increased population pressure must be accompanied by new means for augmenting the output per unit of land, not only to compensate for the declining productivity of labor and the diminishing soil fertility levels of the land, but also for feeding the increased population. If the increased output per unit of land is not achieved, which undoubtedly is the usual case, two other alternatives exist: either the real standard of living decreases, including the possibility that families must give up more of their "leisure time" to work in the shifting cultivation plots, or migration may occur. The selection of the latter alternative is particularly evident in parts of Colombia. For example, certain areas of Huila, a departamento bordering the vast tropical rain forests of the country, have been practically abandoned because of a widespread destruction of the natural resource base. A few "oases" of rain forests stand out in the extensive grassland savannahs as evidence of the destructive past. In the Cauca Valley of Colombia, Crist (1952) reports that many mountain slopes having a thin soil cap have been "desertized" by the prolonged removal of the native vegetation and the exhaustion of the thin layer of humus in the practice of conuco, the local term for shifting cultivation.

Shifting cultivation can lead to the disintegration of social systems. Because periodic migration is necessary, the accumulation of permanent wealth and major concentrations of population are impossible.

Without urbanization, cultivators must remain economically at a subsistence level, without exchange systems, specialization, and a division of labor.

Qualitative Changes In the Fallows

Grass becomes the enemy of soil productivity in a hot, humid climate (FAO 1957). Grassland savannahs can at best tie up only a fraction of the nutrients immobilized by forest vegetation. Unlike trees, grasses have only shallow roots with which to retrieve elements. Hence, should grassland replace forests in the tropics, as has unfortunately happened over thousands of square miles, a permanent lowering of the soil fertility is inevitable. Beard (1944, 1953) and others have spent considerable time classifying these savannahs in the tropical regions of the Americas.

The soils under fire-climax savannahs are characteristically poorer and have a lower agricultural potential than the neighboring soils under forest vegetation (Pendleton 1950). If these grasslands are burned annually, as is the case with most of the tropical savannahs, the soil has little opportunity to regenerate. Kellogg (1963) reports that, with good fallow management, reddish-brown latosols under savannah vegetation in Africa can be successfully cropped for five years at a time with ten to twelve years of fallow. Johannessen (1963), writes that the savannah lands in Honduras were created by the Indians long before the Spanish conquest. Since they had no livestock, the grasses grew luxuriantly during the wet season. During the annual dry season, the grasses were burned, thus eliminating most woody species. When cattle were introduced by the Spaniards, intensive grazing of the savannahs resulted. The cattle tended to select only the palatable species. The grass cover was reduced to the point where there was insufficient fuel to support intense fires, and erosion became severe.

In Colombia, it is customary, in many areas of shifting cultivation, to establish pastures after the land becomes too depleted for good crops. During the first few years, the pastures are very luxuriant and they support a large number of animals. They are usually burned during the dry season to maintain the species therein and to provide a readily available supply of nutrients for the new growth at the beginning of the rainy season. But continuous over-grazing, vegetative degradation, and soil depletion may eventually render the land practically useless. Ultimately, there is no land in the area left for shifting cultivation. This phenomenon is particularly noticeable in the frontier areas where shifting cultivators open up the new land, and then later abandon it or sell it to ranchers and move on in search of new land.

Pedological Phenomena

Watters (1960) lists only four classes of soils in the humid tropics which are sufficiently fertile to support permanent agriculture without difficulty:

1. those occasionally rejuvenated by the addition of volcanic ash;

2. the steepland or unstable soils where an effective "inorganic cycle" is operating;

3. alluvial soils that are periodically renewed by the deposition of river silt;

4. soils derived from highly basic rocks, especially basalt, which have sufficient slope for good drainage.

Unfortunately, these soils occupy only a small part of the tropics. This pessimistic view of the tropical soil resources is shared by many soil scientists. Yet, very little is known about the nature of tropical soils.

Some leading pedologists point to the day when the soil will become merely a synthetic medium for plant growth and man will largely control the reactions he desires to take place. Meanwhile, there is much to be done in solving the mysteries of tropical soils. Laudelout (1960) recognizes two very important factors relative to the soil in shifting cultivation:

1. the decomposition of organic matter during the cropping period and its reconstitution during the fallow period;

2. the immobilization of the mineral nutrients which are locked up in the fallow vegetation and set free when the fallow is cut and burned.

Professor Hugh Popenoe (1957, 1960) of the University of Florida has done extensive work in Central America on the effects of shifting cultivation on soil properties. While most of his work has been confined to the Polochic River Valley in the northern part of Guatemala, many of his findings apply universally to tropical soils. The soils of this hot, humid area are predominantly latosols derived from limestone amd metamorphosed material. The influence of the volcanoes farther south has been only slight through the deposition of occasional ash. The limited virgin forest vegetation in the region is typical of climax rain forest. Trees reach a diameter of up to ten inches during a five-year second growth period.

In describing the pattern of shifting cultivation in the area, Popenoe (1957) mentions that a patchwork pattern of vegetation in all

stages of shifting cultivation may be seen throughout the valley. The cycle is relatively short, and only maize is grown. The land may be cropped for as little as one year. However, a minimum of four years is allowed in the fallow period. Popenoe notes that the first year yields average between ten to twenty bushels per acre, while the second-year yields are halved. Most of the fields are less than ten acres in size.

The most evident soil changes which Popenoe (1960 a) noted in the felling and burning of the forest, were the decreases in the nitrogen content, the organic matter, and the cation exchange capacity. The exchangeable cations (including hydrogen) and the pH are somewhat increased by burning. But this beneficial effect is short-lived because of leaching and erosion. Although the cleared fields generally tend to be more fertile than the soils under forest, continuous cropping soon results in depletion of the temporary supply of nutrients released by burning. The bulk density values increase when the forest is cleared and burned. See Table 2.

Table 2. Physical and Chemical Properties of Soils Under Three States of Shifting Cultivation (Polochic Valley).

Stage	Depth	Bulk Density	pH	N	C/N ratio	K	Ca	Mg	CEC	Base Sat'n.
	inch	g/cc		%		ppm.	ppm.	ppm.	me/100g	%
Forest	0-2		5.75	1.027	15.9	28	6343	964	94.3	53.7
	2-8	0.56	5.74	.486	14.4	97	3264	516	45.2	51.7
	8-16		5.93	.232	10.9	51	2143	435	33.7	45.8
Cleared Land	0-2		6.37	.741	12.0	406	5615	868	68.4	58.4
	2-8	0.71	5.69	.353	13.2	154	2757	539	41.9	43.3
	8-16		6.14	.189	10.5	84	2783	584	39.3	44.4
Second Year Fallow	0-2		5.85	.759	15.2	306	5048	667	75.0	53.3
	2-8	0.70	5.79	.320	11.7	92	3022	347	43.4	45.6
	8-16		6.07	.194	9.4	64	3491	324	35.3	50.0

Reference: Popenoe, "The Influence of the Shifting Cultivation Cycle on Soil Properties in Central America," Ninth Pacific Science Conference Proceedings, Bangkok (1957), Vol. 9, p. 74.

The subsequent second growth after one year of maize (Table 2) reverses the trends brought about by clearing, burning, and cultivation in the following manner (Popenoe 1957):

1. The bulk density decreases, but the low value for the virgin forest is not restored within a period of five years.

2. The pH is lowered and the percent base saturation decreases in the top two inches.

3. The nitrogen and carbon contents increase in the top two inches, and the carbon content decreases in the two to eight-inch zone.

4. Potassium decreases throughout the profile.

5. Calcium continues to be translocated from the topsoil to the lower horizons during the young second growth, but the trend is reversed as the second growth gets larger.

6. Magnesium decreases throughout the profile while the fallow is small, but behaves as the calcium thereafter.

In essence, the effect of the young second growth is to restore the original forest conditions with one major exception (Popenoe 1960 a). The phosphorous contents continue to decline through the fallow period.

In addition to the trends noted above, Popenoe (1960 a) listed the following fundamental relationships of the Polochic Valley soils:

1. The cation exchange capacity appears to be directly related to the organic matter.

2. The pH is directly related to the exchangeable calcium and inversely related to the exchangeable aluminum.

3. The exchangeable aluminum is inversely related to the exchangeable calcium.

4. There is no obvious relation between either the exchange capacity or the organic matter and any or all of the exchangeable nutrient cations.

It may be tentatively concluded, as far as damage to the soil is concerned, that shifting cultivation is practically harmless if it is conducted in equilibrium. Despite the losses of plant nutrients, the amounts remaining after the land is cleared and burned are usually quite adequate for crops the first few seasons. Arguments concerning the physical aspects of the soil are not as substantiating. The effects upon soil structure, and secondary effects such as erosion and the water regulating capacity of the soil are not at all well understood. Information on yields under shifting cultivation definitely verify a downward sloping "fertility curve" after the first year or so (FAO 1958). Whether or not some of this effect may be attributed to increased weed

competition, especially from grasses, has not been established. Bedard (1962) writes:

> The local practice of shifting cultivation is either harmful or not . . . however, the significant point is that if shifting cultivation is practiced in so many different patterns, then certainly it is not the practice itself, but the degree and manner of its application and the locale or environment in which it occurs which should be of concern.

Milpa Agriculture in Central America and Mexico

The Mayan Empire and Milpa Agriculture

Although the Mayan civilization of pre-Columbian Mexico and Central America was based on a rather dense population, the only economic foundation of this culture was milpa agriculture, a form of shifting cultivation. The word "milpa" was used by O.F. Cook (1919) in his classical study of shifting cultivation practiced by the Mayan descendents. Milpa is a Spanish word adopted from the Aztec vocabulary (milli meaning "a planting" and pa meaning "in") the idea being that a maize field, or a clearing in the forest, is cut and burned for planting maize (Cook 1919). Mulba is a Mayan word meaning "to congregate" as to work together in planting a milpa. While this usage of the word milpa is technically incorrect because of its colloquial meaning in Central America and Mexico (a permanently cultivated maize field), it has been used widely by persons writing on shifting cultivation in Central America and Mexico.*

In contrast to the Mayans, the higher civilizations of tropical Asia were based on a more or less sedentary type of agriculture including elaborate systems of irrigation terraces. Nevertheless, the Mayans probably found shifting cultivation to be advantageous in many respects. A minimum of labor and equipment were required, thus freeing abundant human resources for the construction of temples, development of the arts, and the organization of primitive sciences. In fact, the highly structured Mayan society was able to amass a rather phenomenal density of population for a shifting cultivation culture. It has been estimated that at Uaxactún, at the height of the Mayan civilization, there were 48,000 persons living within a ten-mile radius--a density of 470 people per square mile (Gourou 1958).

Yet, the Mayans abandonad this territory in the sixth century. Numerous writers speculate that such a move may be attributed to an exhaustion of the soil resources. Apparently, large areas of grassland savannahs developed around the Mayan cities, thus forcing people to travel much farther in search of fertile land for their milpas as well as for firewood (Bartlett 1951). Without any means for transportation other than the human back, the effective range of operation was definitely

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*Cfr. George W. Hill, "The Guatemalan Highlands Indian and His Poverty Agriculture," a study in process, University of Wisconsin, 1967.

limited. Cook (1919) estimated that it was not uncommon for the shifting cultivators to travel 20 to 30 miles to their plots and even up to 50 to 60 miles from the larger centers. Whereas the Incas (who, incidentally, had a sedentary agricultural system) apparently maintained a policy of withdrawing people from congested areas and sending them to unoccupied regions, the Mayans resisted moves from their population centers. Moreover, they did not have animals to utilize the grasslands as did the Incas. Bartlett (1951) mentions one additional factor which may serve as an explanation for the abandonment of the cities. The streams and shallow ponds in the Petén region of Guatemala, at such places as Tikal and Uaxactún, frequently dry up during the dry season. He speculates that the lakes may have been choked by sediments during the period of heavy agricultural activity in the region.

Redfield (1950) tells how new villages are created by present-day Mayans in the Yucatán. The people in the villages which exist today are compelled to go farther and farther in search of new land for their milpas; consequently, many of them establish milperíos or distant settlements from the villages. Many of these milperíos eventually become villages, especially if the old villages continue to grow much larger. In his prolonged study of the Chan Kom village, Redfield reports that no one has given up milpa agriculture completely. The scarcity of land has resulted in shorter fallow periods and smaller sizes of the milpas over the years. At the same time, the average yield of maize has declined from 0.8 carga per mecate (about 13.6 bu./A.) in 1931 to 0.65 carga per mecate (about 11.1 bu./A.) in the period 1932-1934 to 0.5 carga per mecate (about 8.5 bu./A.) in 1948. The yields of beans, sweet potatoes, yams, squash, and other crops also declined during this time span.

The milperos choose the land for their milpas from the communal lands of the village. A milpa belongs to an individual as long as he clears it and maintains it under cultivation, but it reverts to communal ownership when it is in fallow. In 1948, most milpas were being cultivated for two years and fallowed for about seven years. The total area in cultivation around the village in any given year (both first and second-year milpas) was about 300 acres out of the total communal acreage of 6,000, that is, about 5 percent of the total. Most families have two milpas consisting of about one hectare each. The second year milpa yields average about 25 to 50 percent lower than the first year. From both milpas--that is, about five acres--the average family harvests around 40 hundredweight of maize. Taking the average family consumption as six and one-half pounds per day, or 21 hundredweight per year, this means the average family has some surplus for seed and/or sale.

In view of the growing population pressures, in most parts of Central America and Mexico, it seems that the present-day Mayans, like

their ancestors, may be writing a one-way ticket to destruction. The social costs of milpa agriculture are probably no less today than they were during the Mayan Empire. Cook (1919) was led to conclude:

> From the standpoint of familiarity with tillage methods, the milpa system appears not only temporary, but highly destructive and self-limited since the growth of grasses may render the land useless for a few decades . . . . The essential inferiority of the system lies not so much in its lack of permanence, since this can be assured in proper balance, but in the fact that the carrying capacity must necessarily remain small.

General Aspects of Contemporary Milpa Agriculture

Selection of the site. In the Petén region, the milpero generally chooses the land for milpas on the basis of the type of maize he intends to plant; that is, regular, San José, or Yaxkín (Cowgill 1961). The seed is the same for each of the crops--only the time of planting differs. The regular crop is planted in April or May on the regular slopes. San José is planted in February in low, swampy areas. Yaxkín, an emergency crop, is sown during September on the highest and steepest land. Cowgill (1961) lists some other important factors used in selecting land for the regular crop:

1. where the vegetation is the highest and the weeds and grass are less prevalent;

2. where the soil is dark-colored, has few rocks, and is neither too high nor too low in sand or clay;

3. where the milpero has successfully grown a crop in previous years;

4. where the land is not too high, so the wind and the sun are not problems; and not too low so excess water is not a problem.

Clearing the land. Having selected a site, the milpero will begin to cut the brush in the early part of the dry season (November-January) and allow it to dry until March or April before burning it (Emerson 1953). The larger trees are cut with an axe, whereas the smaller trees and undergrowth are slashed with a machete. With the old method, using limestone fragments, the clearing operation took twice as long (Hester 1952). If the "high forest" is not permitted by government decree to be used for milpas, as is the case in many regions, then land clearing is delayed until February or March.

The second-year milpas are not cleared until April because the milpero is usually busy clearing other land before this time, and the debris cleared from the second-year milpas requires less time for drying before burning (Cowgill 1961). Emerson (1953) also mentions the fact that late preparation eliminates the problem of a weed recurrence before planting, especially since there is hardly enough trash to produce a fire sufficiently hot to destroy the weeds and sprouts.

Interestingly enough, the milperos consider that the first and second-year milpas require equal amounts of labor. Since the second-year milpas provide no kindling wood, they must spend time procuring it elsewhere. Gathering firewood and clearing the first-year milpas are simultaneous operations. Moreover, weeds tend to be a greater menace in the second-year milpas and thus demand more time after planting.

Burning. A milpa is generally burned in sections over a period of several days. Contrary to reports that fires often sweep the whole countryside, most milperos take considerable precaution to avoid fires that would destroy the surrounding forest (Cowgill 1961). Whereas all of the brush cut on the second year milpas is effectively reduced to ashes, the first year milpas are often so covered with trees that it is impossible to get a complete burn. Quite often, a milpero begins planting on the opposite side of a milpa before it is through burning.

Planting. Usually, the planting operation takes place at the beginning of the rainy season. The milperos normally use a five to six foot stick with a sharpened point, or sometimes a metal point (Cowgill 1961). The seed is carried in a gourd suspended from the waist by a piece of string or leather. Maize and ayote, a type of squash, are usually planted together in the Petén region--five to seven seeds of the former, and one to four of the latter in the same hole. The seed is not covered. In some areas, beans are interplanted among the stalks of maize at a later date.

Weeding. In order to remove both the old weeds and newly sprouted ones, the milperos normally wait until after the heavy rainy season before they begin the weeding process (Cowgill 1961). Emerson (1953) observes that by delaying the cutting of the weeds until this time, the milperos permit an abundant crop of weed seeds to ripen and disperse. This, he explains, results in a much greater abundance of weeds in the second-year milpas. In fact, he was led to conclude that the decrease in yields from the first-year milpas to the second year is more a result of increased weed competition than any other factor. Steggerda (1941) ran a series of experiments which influenced him to arrive at essentially the same conclusion. Cowgill (1961), on the other hand, did not find a noticeable difference in the weed densities between first and second-year milpas.

Harvesting. At harvest time, the ears of maize are cut off the stalks with a machete (Cowgill 1961). If there is a surplus over family needs it is frequently dumped onto the market soon after it is harvested. The price of maize falls considerably during the harvest season. Apparently, storage facilities are very inadequate and rodents are a serious problem. The other crops in the milpas are harvested as they mature and are mostly self-consumed.

Fallowing. Although most milperos hold their first year milpas over for a second year, third-year milpas are not common. However, Tax (1963) reports that in Panajachel, Guatemala, the gentler slopes may be cropped continuously up to 25 years and the steeper slopes up to ten years before allowing a six-year fallow. The soils in this area are derived from volcanic ash. He estimates that the average yields are about 30 bushels per acre in the area.

Yields are the criterion for "exhaustion:" that is, they determine the difference between "tired" and "fresh" land. As has been discussed previously, the decline in yields has been attributed to a multitude of causes, including a decline in soil fertility; an increase in weed competition, especially grasses; the inability to kill off insects and weeds when the fields are fired during the second season because of insufficient fuel furnished by the meager vegetative growth during the previous year; and the loss of soil due to erosion of the exposed milpa during the first year (Hester 1951). Cowgill (1961) notes that the most prevalent deficiency symptoms in the milpas of the Yucatán, in decreasing order of frequency, are nitrogen, phosphorous, zinc, and manganese. He argues that the deficiencies are much more pronounced in the second-year milpas. Another interesting observation which he made was the tendency for milpas to be planted on old archeological mounds wherever possible. Yields were higher on these mounds, chiefly because of the higher levels of phosphorous.

Tax (1963) has used some old figures to demonstrate a differential in costs and returns between "hill land" and "delta land" milpas in Guatemala (see Table 3).

The higher fertility levels of the delta soils allow the milperos to extend the cropping period for a much longer period of time than that on the hill lands. Apparently, maize alone is produced on this land, because of its very noticeable response to fertility or because the delta lands may be subject to periodic flooding during the rainy season.

Tax (1963) has also been able to ascertain differences in the labor requirements among the various types of land. Table 4 shows the number of man-days, defined as the amount of work done by a full-grown man in one working day of about nine hours, required by new land, old land, and delta land. In this table, the new land and the old land both refer to the first year and successive year milpas, respectively, on the

Table 3. Costs and Returns Per Acre of Milpa, 1936.

Item	Hill Land	Delta Land
Costs		
Labor	$ 8.33	$ 6.00
Seed	.18	.10
Ceremonial	.08	.02
Total	$ 8.59	$ 6.12
Gross Returns		
Maize	14.00	24.50
Beans	1.20	-
Squashes	3.00	-
Total	$ 18.20	$ 24.50
Net Returns	$ 9.61	$ 18.38

Reference: Tax, Penny Capitalism, Chicago: University of Chicago Press (1963), p. 108.

Table 4. Labor Required to Grow Ten Cuerdas (1.78 Acres) of Milpa.

Work Process	Number of Man-days		
	New Land	Old Land	Delta Land
Cutting trees, etc.	20	-	-
Making fire lanes	2	-	-
Burning fallen trees, etc.	2	-	-
Stubbling	-	10	-
Cleaning	10	10	10
Planting	5	5	5
Replanting where needed	1	1	1
First cleaning (and hilling)	20	20	20
Second cleaning (and hilling)	20	20	20
Harvesting	5	5	5
Transporting	10	10	1
Storing	3	3	3
Threshing beans	3	3	-
Total per ten cuerdas	101	87	65
Total per acre	57	49	36

Reference: Tax, Penny Capitalism, Chicago: University of Chicago Press (1963), p. 109.

hill land. The overall labor productivity remains considerably higher on the delta land, not only because of the higher yields, but also because the extended cropping period allows the milpero to spread the labor requirements for clearing over a greater number of years. The other major difference is made up by the low transportation requirements for the delta land. Probably, more trips are necessary for transporting the products from the hill land since the squashes and beans may not mature uniformly. The table also tends to refute the arguments set forth by Emerson (1953) and Steggerda (1941) that the old land necessitates more labor for weeding.

The fact that more fertile soils, especially the soils derived from volcanic ash and from recent alluvium, are able to support adequate crops of maize for a period up to 25 years would seem to lay emphasis upon declining soil fertility as the major ill of second year milpas. At any rate, fallow periods seem to provide the best remedy, if they are long enough to allow the dominant trees to reach a size satisfactory for cutting and to choke out the smaller growth, including weeds.

Other Aspects of Shifting Cultivation Systems

Opposition to Shifting Cultivation

Despite the long occupation of extensive tropical areas by colonial powers, and the more recent attempt of the developed temperate nations to inject technical assistance into the under-developed tropical countries, the ecological systems of the tropics are not well understood. By and large, attempts to transpose temperate agricultural practices to the humid tropics have met with only moderate success--some have failed miserably. For reasons that have been discussed earlier in this paper, shifting cultivation has been strongly opposed by most technical advisors from the temperate regions. Perhaps no words of condemnation have resounded more clearly than those of the FAO Staff (1957):

> Shifting cultivation, in the humid tropics, is the greatest obstacle not only to the immediate increase of agricultural production, but also to the conservation of the production potential for the future, in the form of soils and forests.

Nevertheless, efforts on the part of governments to force the abolition of shifting cultivation have been almost completely futile.

Leach (1959) suggests that administrative opposition to shifting cultivation is usually focused on two aspects: (1) the destruction of valuable forests, and (2) the dangers of deforestation and erosion. To the shifting cultivator, the first factor probably appears irrelevant for he generally possesses no means by which to gain benefits from the

harvest of forest products. To him, the forest is a weed or, at best, a repository for plant nutrients and a source of fuel. This latter aspect becomes relevant to the cultivator only when the supply of forested land is scarce, or when migratory movements of the population are artificially restricted by governmental action. Naturally, a practice that is so ingrained in so many cultures is not likely to disappear, nor even modify, unless widespread institutional changes are effected.

Adaptation of Shifting Cultivation into New Systems

Explanations of why the agriculture of some cultures evolves more or less automatically into more intensive forms have mostly focused on demographic pressures and deteriorating resource bases. In the northern part of Burma, Leach (1959) has observed little cultural variation between the shifting cultivators and the farmers practicing terraced field agriculture: they are "precisely the same tribal peoples." He writes that where the local population density is so high that the land is scarce, terraced agriculture is the standard, traditionally established, preferred technique. This intensive form of agriculture requires much more labor, which the higher population supplies, and it can be relied upon to produce moderately good yields. On the other hand, where the population pressures are not so great, shifting cultivation is by far the dominant form of agriculture. Under this system, very high yields are possible if the forest cover is dense. Leach feels that there is a very definite point at which farmers consider it advantageous to make the change from shifting cultivation to terraced agriculture.

Numerous attempts have been made to intensify traditional forms of shifting cultivation, both directly and indirectly, through control and/or development mechanisms. De Haan (1959) suggests three ways for restoring the imbalance between the land and the people:

1. the improvement of the system of shifting cultivation so that the use of land is better suited to the potentiality of the soil under the conditions of a higher population density;

2. the reduction of economic isolation of an area so that products can be marketed and so that means become available to increase agricultural production and prevent further destruction of the land;

3. the opening up of isolated and closed communities, the freeing of human forces, and the encouragement of initiative to make efficient forms of agricultural production more attractive.

The classic example of an attempt to modify a traditional form of shifting cultivation is that of the "corridor system" in the Congo. For centuries, the nomadic "Bantu system" of agriculture prevailed among the tribal societies of the Congo. European intervention, however, precipitated an ever-increasing destruction of the forest cover through intensive agricultural production means geared to the demands of export and urban economies. De Coene (1956) describes the following effects of European colonization in the Congo:

1. more and marked depletion of the soil;

2. an extension of the cultivated area without a corresponding increase in yields;

3. an ever-growing fragmentation of fields due to the search for fresh, fertile soils, thus increasing the nomadic way of life of the natives and diminishing the efficacy of propaganda;

4. an impoverishment of the rural communities which, because of their small incomes, searched for more profitable labor alternatives.

European methods such as deep plowing and leguminous fallowing had brought deplorable results in the tropical setting.

In an effort to counteract the aforementioned effects of European intervention, Belgian scientists devised a rational system of shifting cultivation out of the old Bantu system. This scheme, known as the "corridor system," involved the laying out of strips or "corridors" through the rain forest and the designation of blocks therein, based upon the feasible number of years for the cropping and fallowing phases of the cycle (Kellogg 1963). This system allowed a new block to be cleared and an old block to be retired to fallow each year. The size, shape, and orientation of the blocks were all found to be of paramount importance because of the influence of the forest border (De Coene 1956). Although mixed plantings of upland rice, maize, bananas, and manioc have performed best under this system, a single year of cotton or peanuts grown in the middle of the cropping phase has done well, especially if fertility practices are used. The successful production of commercial crops in the "corridor system" is indicative of the fact that improved forms of shifting cultivation can go beyond the realms of subsistence agriculture. The "corridor system" makes possible permanent villages and homes, whereas the old Bantu system resulted in migration as the soils deteriorated and the savannahs encroached (FAO 1958).

In Colombia and other parts of Latin America, a modification of the traditional system of shifting cultivation has proved to be quite important in the management of certain tree crops, especially coffee and cocao. The number of diseases which plague these crops makes it

necessary to re-establish the plantations periodically. The normal procedure for doing this is the complete removal of all the crop trees and shade trees by felling and burning. New seedlings are then planted along with intermediary crops such as maize, beans, manioc, and plantains. The latter is especially important as an intermediary crop because it provides the necessary shade for the young crop trees until the new shade trees become established. Whereas the traditional systems of shifting cultivation have been strongly opposed by the officials responsible for the extension activities of these crops, the modified system is widely accepted as the most efficient and effective means of controlling tree crop diseases and establishing new plantations.

Relationships Between Shifting Cultivation and Land Tenure Systems

In contrast to the shifting cultivation systems in many parts of Africa and Southeast Asia, where the basic unit is often the tribe, most forms in contemporary Latin America focus upon family units. This fact has important implications for land tenure systems. In the former case, the decisions regarding the use of a specific area of land must satisfy the goals of a considerable number of people; the individual is subordinate to the tribe. Land use practices within the tribal domain are closely linked to ritualistic patterns.

The family, on the other hand, is a more flexible unit, not only from the standpoint of fixity on the land, but also with respect to land use. Where plenty of land with good forest cover is available, the boundaries of family holdings are likely to be loosely defined and migration will be frequent. In Panama, for example, a form of shifting cultivation known as roza is the basic farming system throughout the country. Guzmán (1956) reports that, in 1950, more than 72 percent of the country's farms had fewer than ten hectares and nearly all of these farms were practicing roza. Only 3.2 percent of the total land area of the country was under cultivation, four-fifths of which was reported to be in subsistence agriculture. A large proportion of the country's farmers possessed no titles to their land; they selected their plots freely from the vast forested regions.

Apparently, the land tenure system itself represents one of the greatest obstacles to the adoption of technically feasible modifications in land utilization. Where the ownership or control of a tract of land belongs to a tribe or some party other than the cultivator, there is little incentive for improvement, especially if the supply of good land is abundant. The cultivator's interest in the land will cease when he abandons it to natural fallow. Likewise, the physical isolation of a cultivator from markets and the paucity of other agricultural services will dampen the incentives for making permanent land improvements.

Shifting cultivation itself does not appear to be a manifestation of certain land tenure systems. However, it is usually associated with primitive land tenure patterns in tropical regions of economic isolation. Whether shifting cultivation remains a rational practice under more advanced land tenure arrangements has not been well substantiated. De Schlippe (1957) suggests that one must determine whether shifting cultivation, in natural balance with the local environment, is in certain cases better than alternatives which can be introduced as a result of acculturation. The problem becomes one of how to plan a synthesis between local and universal values, given a specific natural environment. It seems that structural changes in the land tenure system, together with a fuller political participation of the cultivators and an expansion of the agricultural service structure would be necessary to foster long-run improvements in land utilization.

Summary and Conclusions

In comparison to most temperate regions of the world, the tropics are teeming with physical constraints upon agricultural productivity. Where man has remained subservient to such a rigorous environment, it is no great mystery why he has lapsed into a universal ecological pattern. Despite the overwhelming importance of the physical milieu in molding land utilization schemes, cultural influences cannot be easily abstracted. Although shifting cultivation has traditionally been a very rational system among many societies of the world, and numerous attempts have been made to modify and improve its traditional forms from the standpoint of ecological adaptation and labor efficiency, it must be generally concluded that the system is not compatible with an industrial society. A modern economic system requires the concentration of human population with a specialization of tasks and a constant augmentation in the productivity of agriculture in order to feed and capitalize the non-agricultural sectors of the economy.

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