Shifting cultivators

Local technical knowledge and natural resource management in the humid tropics

by

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Preface

In 1990, within its Forestry for Community Development Programme, the FAO Forestry Department published Community Forestry Note 4, "Herders' Decision-Making in Natural Resources Management in Arid and Semi-Arid Africa". This was the first step in filling an information gap on what knowledge rural people have developed in the management of trees and forests in relation to their production systems.

Dr. Katherine Warner, an anthropologist with a special focus on shifting cultivation systems, follows with this Community Forestry Note 8. "Shifting Cultivators" highlights the local technical knowledge applied by swidden/fallow farmers when making resource management decisions. This is an especially timely volume as it brings together data and provides valuable analysis of a practice that is currently in ill repute with forestry planners and environmentalists. Dr. Warner does not claim that shifting cultivators can continue with their systems, especially in the face of competing land and tree uses for their fallow areas. She does, however, point out valuable lessons that can be learned from the long-term swidden/fallow cultivators about sustainable use of tropical forests. She provides suggestions for the evolution of systems based on what these women and men farmers already know and use in providing a livelihood for their families in difficult tropical environments.

The development of "Shifting Cultivators" was supported by the Community Forestry Unit and by an interdepartmental working group and a number of outside reviewers. The study was partially funded from a multi-donor trust fund, Forests, Trees and People, dedicated to increased sustainable livelihoods for women and men in developing countries, especially the rural poor, through self-help management of tree and forest resources. "Shifting Cultivators" is to be followed by documents on private tree management of single trees (for production of various products) and of trees in spatial arrangements (including indigenous agroforestry), and on communal management of woodlands. It is hoped that this series of studies will prove useful in pointing out the importance of local knowledge and resource management strategies, and will provide more effective support of local people in their effort to improve their current and future well-being through better tree and woodland management.

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Executive summary

Integral swidden has been, and continues to be, practiced throughout the tropics. Integral swidden is a land use system based on a "traditional, year-round, community-wide, largely self-contained and ritually sanctioned way of life" that is still prevalent among tribal minorities in Southeast Asia and South America and a small, declining percentage of African farmers (Conklin 1957:2). Swidden agriculture is one component, albeit the major one, of the larger agroecosystem. This agroecosystem includes not only agriculture, but also forest collection, hunting, fishing and, in some areas, cash cropping.

All too often in the past swidden was perceived as exploiting, not managing, the natural resources of the humid tropics. However recent research, and reinterpretation of past research, has shown that natural resource management does occur. The natural resource management of the integral swiddener is focused on maintaining the highly valued diversity of the forest ecosystem. Although the forest may be cut, the swidden practices of small dispersed clearings, selective weeding, and planting and protection of trees actually aid the forest in its return. Other resources, such as animals and fish, are also managed within a worldview that looks beyond immediate needs to future sustainability. Such swidden/fallow systems are not rigid in their adaptation, but show flexibility in response to changes in the environment or to shifts from one locale to another.

Analysis of numerous examples of traditional practices suggests that the integral swiddener succeeds by accepting and working within the constraints of the natural processes associated with the year-round growing season and rapid ecological succession in the humid tropics. The utilization of natural processes, combined with an intimate knowledge of the microenvironments of forest and field and the microsite needs of specific crops, enables swidden/fallow to succeed where other land use systems have failed.

Although successful in the past, swidden-based agroecosystems cannot serve as the model for the future of the tropics. The tropical forest, so crucial for the swidden/fallow agroecosystem, is precipitously declining in area as it falls under increasing pressure from landless settlers, logging concerns, and national financial needs. However the local technical knowledge found in integral swidden societies can contribute to better natural resource management and the development of sustainable agroecological systems.

Swiddeners can be active participants in designing new agroecosystems to meet the challenges of a constricting resource base. There is a need for on-farm research in swidden communities to aid in the development of new cropping systems for intensification of the swidden system. Such research may also lead to innovations that can be utilized by non-swidden smallholders in the tropics.

It is also recommended that agricultural and forestry extension agents be trained in the general principles of swidden systems: utilization of microenvironment differences, integration of trees into smallholder agroecosystems, and perception of agriculture as being one component in the larger agroecosystem.

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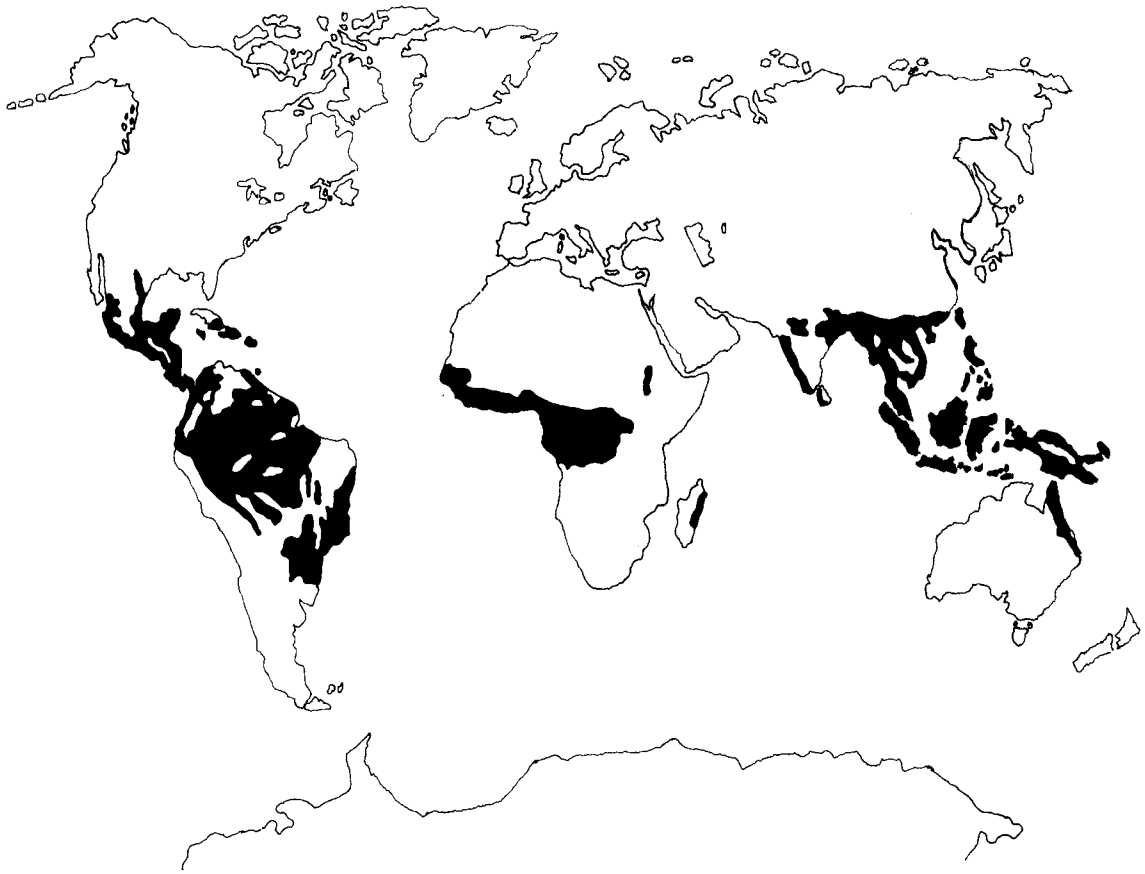
Chapter 1

Local technical knowledge, shifting cultivation and natural resource management

INTRODUCTION

This forestry note will examine the local technical knowledge (LTK) of the traditional swiddener and how it is utilized for natural resource management in the humid tropics. Starting with a review of the environment of the humid tropics and the problems of natural resource management in the region, the note will go on to an analysis of shifting cultivation as a natural resource management strategy for the tropics. Examples from three major regions of the humid tropics -- the Amazon basin, Southeast Asia and Africa -- will be used to illustrate shifting cultivation practices as adaptations to the local social and physical environment. In the Amazon and Southeast Asia the focus will be on the tribal minorities who have on the whole been very effective in using and maintaining the tropical forest. The focus in Africa will be on the swiddener's response to a less certain environment and the ways in which intensification is occurring.



LOCAL TECHNICAL KNOWLEDGE AND NATURAL RESOURCE MANAGEMENT

Tropical deforestation is increasingly a focus of international environmental concern. Current projections of large-scale deforestation of the tropics create a scenario of flooding, drought and wide-scale erosion that would make vast regions unarable. Some recent work on the possible global effect of tropical deforestation has suggested scenarios of a warmer world. Whereas before the tropical forests were seen as a natural resource to be nationally managed, now there is growing sentiment that the tropical forests are a global resource whose management is of international concern. As a result of this new belief, once the grim projections are presented it is asked: What has been done to protect the forests? Who is destroying the forest? Why are not they stopped?

In the past (and even in some instances today) shifting cultivators were the primary recipients of blame for the deforestation of the tropics. Attempts were made to stop them by governments and international organizations, who perceived them as wantonly destroying the natural resources of nations. To blame them and make laws forbidding the cutting and burning of the forests was easy, stopping shifting cultivation was not. Shifting cultivators exist today and will continue to exist well into the future.

Recent studies have shown that much of the blame was misdirected. Rather than wantonly destroying the forest after a clearing has been used for cropping, many shifting cultivators actively reestablish the forest. Shifting cultivation is a complex agricultural system that is well-adapted, under certain conditions, to the environmental limitations of the tropics. It is not primitive nor necessarily destructive. It requires in-depth knowledge of the tropical environment and a high degree of managerial skill to succeed.

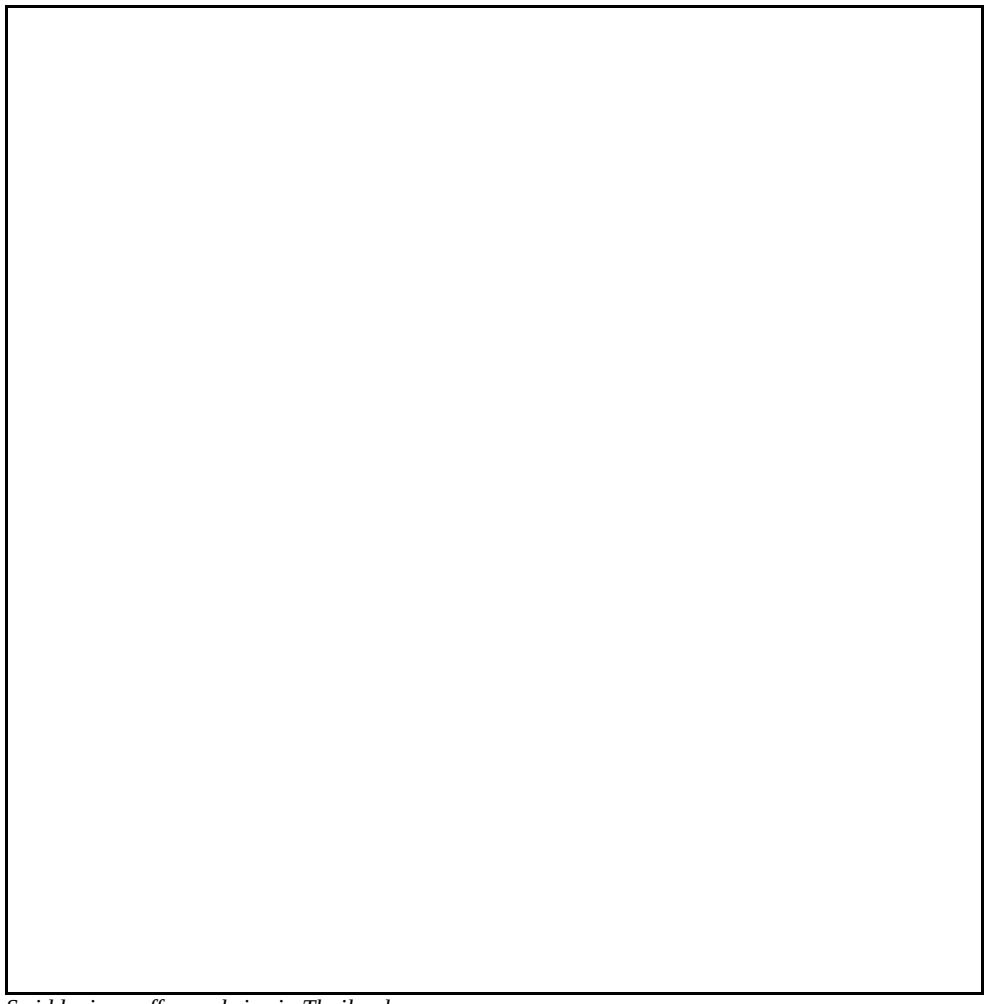
This new viewpoint of shifting cultivation has been reinforced by the failure of agricultural development projects in the tropics. As will be shown later, the tropics is a difficult environment in which to intensify production. Projects have failed, in many instances leaving behind grassland where forest had been just a few years before. Yet shifting cultivators in the same region cleared and burnt the forest, planted and harvested their crops, and the forest reestablished itself. Why should the technically sophisticated projects create "green wastelands" and the primitive shifting cultivator forests? Or to ask the question in another way: what do they know, what do they do, and why do they succeed in the tropics when other approaches fail?

Local technical knowledge

As used in this note local technical knowledge (LTK) will refer to practical knowledge of the environment and procurement strategies based on intimate experience accumulated over many generations (Bodley 1976: 48). When studying the local technical knowledge of shifting cultivators, basic data of "environmental resources, plants, animals, land types, soil, water and crops" have to be gathered (Knight 1980: 222). But an ethnobotanical list of plants and classification of soils, etc., although necessary, is not enough. It is not just what a shifting cultivator knows of the environment that is important. It is how that knowledge is utilized. Based on this environmental knowledge and perception, given possible crops, land and labor availability, what does the farmer do? In the study of LTK it is necessary to go beyond categories and attempt to understand how this knowledge is used by the farmer to develop procurement strategies that provide nutritional security.

The swiddener's primary use of environmental knowledge is in making decisions as to what to do and when to do it. This is when that knowledge is put to the test; if it succeeds, it remains in the knowledge pool; if it doesn't work, it may be relegated to the "no longer useful" category and dropped out of the pool. Yet the swiddener's "decision making sequence" depends on more than environmental knowledge; there are also certain constraints or givens that limit the area of choice. These constraints may be social, cultural or environmental (Ellen 1982). Some of these constraints may be of short duration (marital status, young children, illness), others may be constant and relatively unchanging (climatic factors that disallow certain crops). Using LTK and operating within these constraints the swiddener makes decisions and creates a viable food production system.

This perception of the farmer as a decision maker who considers his "biologic and economic resources" and makes decisions "aimed at the achievement of agricultural production and at maintaining soil fertility" supports the current view that the agroecosytem (agricultural system as a component of the larger "natural" ecosystem) is dynamic and responsive, rather than static (Benneh 1972:245). The agroecosystem approach supports the perception of the farmer as an *active* participant with his culture having coevolved with the environment to create a viable food procurement system (Gliessman 1985:56). As the interactions between man, his culture and the ecosystem create changes, these in turn will encourage other changes as new decisions are made after a reappraisal of the resources. This dynamism, with its complex feedback mechanisms, provides a better understanding of how the swiddener integrates the natural environment and the agricultural system to maintain agricultural production (Gladwin 1983, Olafson 1983, Warner 1981, Benneh 1972).



Swiddening coffee and rice in Thailand

What are the natural resources?

Although practiced in temperate forest climates in the past, shifting cultivation is an agroecosystem currently found mainly in the humid tropics. The humid tropics is defined as a region with the following characteristics:

1) all months with monthly mean temperatures above 18° C,
2) during the growing period 24-hour mean temperatures above 20°C,
3) more than a 180-day growing period.

This represents an area of almost 2500 million hectares in four regions: Africa, South America, Central America and Southeast Asia (see Table 1). In Africa and tropical America there is a distinct concentration of the tropical humid ecozone within two river basins. In the tropical Americas 75% of the humid tropics is located in the Amazon basin. The Amazon basin is so large that it alone contains over 40% of the total humid tropics (Sanchez 1987). In Southeast Asia the humid tropics includes the mainland and the equatorial islands of Southeast Asia, excluding the upper reaches of the mountains.

Although all the regions share the general conditions of the humid tropics, there is some variation of rainfall between and within the regions. The rains of South America are the most certain, with the least monthly variation, while in almost all of tropical Africa there is a distinct dry season of 1 - 2 months when there is less than 100 millimeters of rain (Richards 1973).

The natural resources of the humid tropics: forest and soils

Forest: The natural vegetation of the humid tropics is forest (Richards 1977; Hadly and Lanly 1983). There are two main forest types: the closed forest and open forest (Hadly and Lanly 1983). The closed forest grows where average annual rainfall is above 1600 millimeters. The closed forest has a continuous canopy, is multi-layered, and usually has an abundant undergrowth. Depending on the particular region it can be either broad-leaved, coniferous or bamboo. The floristic make-up may differ but each is adapted to similar conditions: high rainfall and high temperatures (Hadly and Lanly 1983; Richards 1973).

In areas where there is 1200-1600 mm. of rain, the natural cover may be either open or closed forest depending on the length of the dry season, soils, etc. (OTA 1984). Open forests are found where rain is from 900-1200 mm. in regions that are drier than those that support closed forest. The open forest is a mixed forest and grassland vegetation type. The tree canopy is broken but covers more than 10% of the ground.

Closed and open forests are unevenly distributed in the tropical regions. Tropical Africa has only 18% of the closed tropical forests, but contains 66% of the world's open forest. The open forest is characteristic of the drier "edges" of the Congo basin and East Africa. Tropical America has 57% of the world's closed tropical forests, most of that within the Amazon basin. Asia contains 25% of the closed tropical forest, but almost half of it is in Indonesia (Hadly and Lanly 1983: OTA 1984).

It is the closed tropical forest that is biologically the most complex and the richest in species diversity. It is this same forest that is being cleared. Man, especially after the adoption of agriculture as a subsistence pattern, has been responsible for the transformation of an estimated 1000 million hectares of the humid tropics, an area equal to the Amazon basin in size, into semi-desert (Bene et_al 1977). The pace of deforestation has quickened during the last 20-30 years, as ranching, plantations and lumbering have expanded and migrants have moved in increasing numbers into the tropical forest (Richards 1977).

Table 1. Extent of warm humid tropics (million ha.)

Region	Africa	South America	Central America	Southeast Asia	Total
Extent of warm humid tropics	911.7	1001.5	76.3	491.8	2481.3
Percentage of total area in region	31.7	56.5	28.1	54.8	38.2

Source: Ofori, Higgins and Purnell 1986 (citing FAO 1980; 1981; 1982)

When undisturbed, tropical forest ecosystems are stable. The stability of the tropical forest ecosystem is the result of its capacity to "withstand climate and other hazards of the natural environment" (Richards 1977: 230). Several characteristics of the tropical forest create this stability:

1) The humid tropical forest is rich in the number of species of plants and animals. It is the high level of species diversity that provides stability to the forest ecosystem.
2) The tropical forests are highly complex, the most complex of terrestrial ecosystems (Connell 1978). Plants and animals are intimately linked within the tropical forest ecosystem. Animals in the tropical forest fulfill the role played by wind in the temperate forest for seed dispersal and pollination (Hadly and Lanly 1983: 5). Since the tropical forest is far more diverse in species and the animals not far ranging, this reestablishes and maintains local diversity.
3) Since tropical soils are generally poor in nutrients, the tropical forest ecosystem depends on a self-contained, almost closed, nutrient cycle. The nutrients that are cycled in the system are in the biomass, which serves as a form of vegetative storage. The forest itself acts like a giant "sponge" in its recovery and recycling of nutrients, with 65 - 85% of the vegetation's root system found within the topsoil layer (Hadly and Lanly 1983; Uhl 1983; Moran 1981).



The tropical forest ecosystem depends on a self-contained, almost closed, nutrient cycle.

Amazon studies have shown the importance of the root "mat" of the trees in the nutrient cycle. The root mat, made up of the extended roots of trees intermixed with organic matter and mycorrhizal fungi, lies on the top of the soil and covers the forest floor. When leaf litter, twigs, or even fallen trees fall to the forest floor and start to decompose, the root mat absorbs the dissolved nutrients before they can be leached down into the soil (Stark and Jordon 1978). Since 10 -20% of the total biomass dies off and drops to the ground each year, the amount of nutrients recycled through the system is large (Moran 1981).

This system is so efficient that "the concentration of some nutrients in the streams that drain from the forests [is] actually lower than the concentration in the rains falling on them" (Uhl 1983:70). Within the forest not only trees but other plants, as well, have developed a diminished dependence on the soil -- epiphylls, which live on the leaves of trees, are able to absorb nutrients from rainwater and fix nitrogen from the air (Uhl 1983). It is an ecosystem that once established is self-sustaining as long as the rains continue and it is left undisturbed.

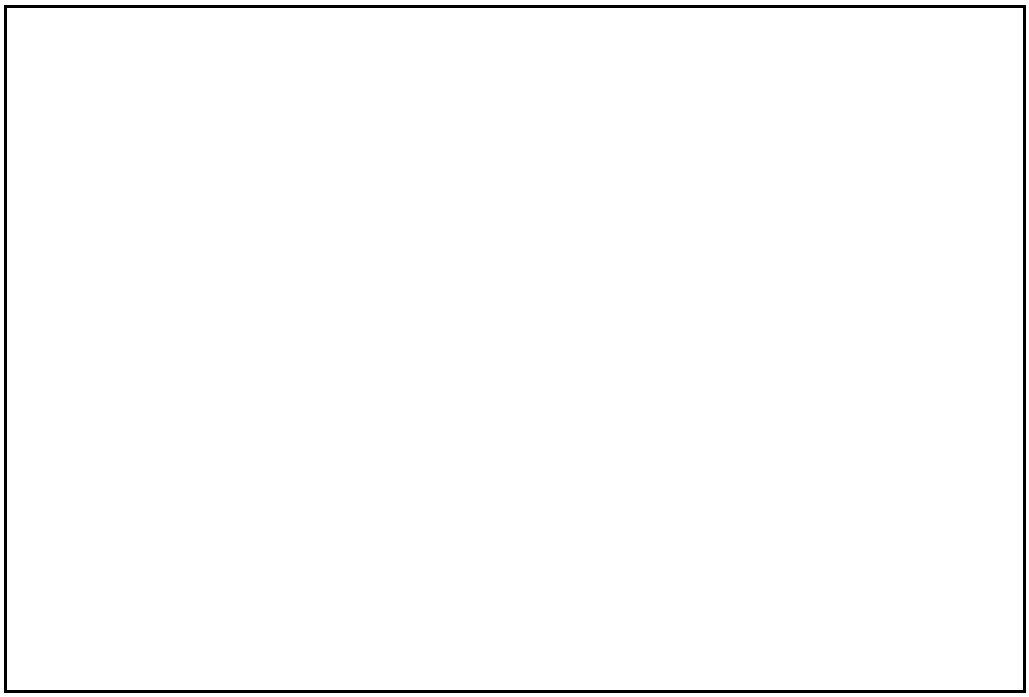
Yet the forest, however stable, is not static. Part of the self-sustaining process of the forest is the natural "felling" of the trees. The tropical forest is not an "old" forest, for there is constant change and renewal through the blowing over and falling of trees. The fallen tree creates a gap in the canopy and a patch of sunlight is then able to reach the forest floor. The larger the gap, the larger the microclimate, and the more varied the vegetation in the gap will be from the surrounding closed canopy forest. In an ecosystem where the nutrients are stored in the biomass, a fall of a tree per acre per year provides a substantial nutrient boost (Hadly and Lanly 1983; Uhl 1983; Hartshorn 1978; Whitmore 1978).

The high frequency of tree falls, especially in those areas of the tropics that experience severe storms or cyclones, prevents most trees from ever reaching their full potential in size or age. The successional tree species are dependent on the gaps, since they could not become established without the sunlight and flush of nutrients that a tree fall creates. The particular successional species that becomes established in the gap is determined in turn by the particular plant-herbivore relations in the locality. These factors create a forest mosaic of gaps in the canopy and various stages of growth in the understory that gives the tropical forest its unique diversity of plants and animals. It is a dynamic forest with rapid growth of early successional species and the relatively slow growth of the mature forest species creating a forest of patches in various stages of regrowth within the overall stability of the mature forest (Hadly and Lanly 1983; Hartshorn 1978; Whitmore 1978).

But this stability can exist only within the context of the natural process of renewal. Tropical forests are very vulnerable to man, especially when man enters the forest not with an axe, but with a chainsaw and bulldozer. The very factors of diversity, complexity and closed nutrient cycle that sustain the tropical forest ecosystem in an undisturbed setting cause its fragility when in contact with man. Rainforests, because of the high degree of specialization of the individual species, have a low ability to recover from large-scale disturbances by man (Goudie 1984; Hill 1975). The very complexity of the tropical forest ecosystem that creates stability in a natural state, also makes it vulnerable to man-created disturbance.

This vulnerability is increased by the way in which revegetation of the tropical forest occurs. There are four main pathways for the reestablishment of the forest when a clearing occurs naturally with a tree fall or when the cleared area is small (less than three hectares):

1) the rapid growth of seedlings and saplings present in the shaded understory on the periphery of the opened area, which quickly respond when sunlight becomes available;
2) plant regeneration from the stems or roots of damaged trees;
3) the germination of seeds of fast growing successional species that require sunlight and are lying dormant in the soil;
4) the introduction of seeds from the surrounding area. Forest tree seeds are generally too large to be easily dispersed; they fall onto the forest floor. But the seeds of the pioneer species can be carried in by animals, birds or bats (Janzen 1973, 1975) or by wind. This means that a gap will be initially colonized by pioneer plant species, which may later be replaced in the succession by tree species (Uhl 1983).



Tree seeds can be carried into the clearing by animals, birds or bats.

While these pathways are effective when the clearings are small, their limitations are apparent when a large clearing is made by logging or the use of a bulldozer. When large areas are cleared using these methods seedlings are left only on the far perimeter with no trees remaining within the clearing to resprout; dormant seeds are scraped up with the forest soil, and reseeding by fauna is impeded since the bare gap is too large to attract birds and bats, or for an animal to feel comfortable to enter (Jordan 1985). Since the reestablishment cycle is adapted to the small gaps that might occur with tree falls, large clearings, especially those made by modern loggers or by the use of bulldozers, make reestablishment of the forest virtually impossible (Jordan 1982; 1985).

Compounding this is the nutrient cycle of the tropical forest. With nutrients stored in the biomass, once the the forest is cleared there is a lack of nutrients available to sustain new plant growth. Without the protection of the forest cover from the heavy rains, the soil washes away, while exposure to the sun hardens the soil. The size of the gap, the removal of the topsoil, and the exposure to rain and sun combine to dramatically

slow down the succession to forest. It may take a thousand years for a field of 15 hectares cleared by bulldozer and then weeded, to become forest again (Uhl 1983).

Soils: Although there is great diversity of specific soil types within the humid tropics, the great majority of the soils of the region are nutrient deficient (Jordan 1985). In the humid tropics of Africa, Southeast Asia and the Amazon the problems of phosphorus deficiency, aluminum toxicity, drought stress, and low inherent fertility are common and well recognized (Sanchez 1987; Lal 1989; Moorman and Kang 1978). The amount of rainfall appears to be what creates the poor soils of the region, for if the rainfall of an area exceeds 1000 mm., the soils are usually found to be acidic and leached (Sanchez 1987).

The nutrient deficiencies of the tropical soils are the great limiting factor in tropical productivity. These "old, highly weathered, and excessively leached" soils do support tropical rainforests, but the forests do not depend on the soil for nutrients (Lal 1987:16). Instead, the tropical forest ecosystem bypasses the soil and creates a nutrient cycle based on its own biomass. Unlike the temperate areas where size of the trees in the forest provides a rough measure of soil fertility, the size of the trees in a tropical forest does not indicate the nutrient level of the soils beneath it (Jordan 1982; 1985). Nutrients flow from leaves, fallen trees, etc., through the mycorrhiza and shallow roots of the surface root mat back into the biomass "without ever becoming part of the soil proper" (Beckerman 1987: 64; Went and Stark 1968).

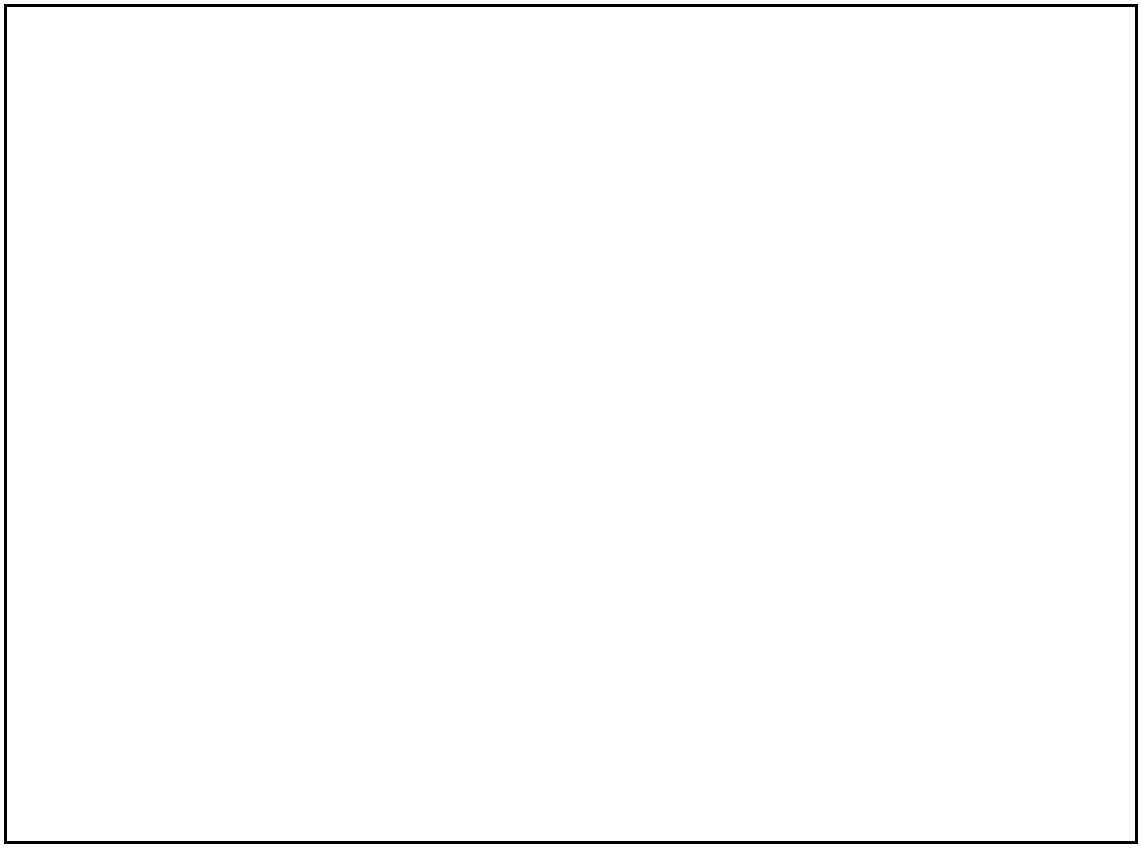
Once deforestation occurs and the forest ecosystem nutrient cycle is broken, the soil loses nutrients and its physical structure is weakened. Although the tropical forest may not have been dependent on the soil for nutrients, the tree roots hold the soil and serve as channels for water infiltration, while the forest litter buffers the soil during the rains (Goudie 1984). When forest cover is removed, the soil is susceptible to compaction, loss of water retention properties, and the loss of important macrofauna (earthworms and termites), which provide nutrients and improve the physical structure of the soil (Lal 1987). When deforestation occurs, the protection provided by the forest for the soil is removed. Deforested sites, especially if more than a few hectares in size, experience accelerated, and possibly severe, erosion when exposed to heavy rains.

However, as with forest regeneration, the size and method of the clearing determines the vulnerability of the soil to erosion. If the clearing is small, no more than 2 or 3 hectares, and surrounded by forest, vegetation will quickly reappear and loss of soil to erosion will be minimal. If the area is large, the soil will quickly decline in nutrients and be vulnerable to erosion. But even a small area can experience severe runoff and erosion if a highly disruptive method of clearing is used.

Table 2. Effects of methods of deforestation on runoff and erosion

Clearing treatment	Runoff ($mm\ y^{-1}$)	Soil erosion ($t\ ha^{-1}y^{-1}$)
Traditional clearing (selective cutting)	3	0.01
Manual	35	2.5
Sheer blade	86	3.8
Tree pusher/root rake	202	17.5

Source: Lal 1987



Clearing a small area by traditional means in Honduras

Clearing the forest by traditional and manual means results in less severe soil erosion than occurs on land cleared by mechanized means, especially tree pushers (see Table 2). The method of clearing with the least runoff and erosion is the "traditional" in which machetes and axes are used; the method that has the highest rates is the tree pusher/root rake. The differential rates of erosion are the result of what remains at the site after the forest is cleared. Traditional methods leave tree stumps and untouched root systems with little disturbance of the forest litter -- while the full protection of the forest cover is gone, there are still roots to bind the soil, and litter to buffer the impact of the rain splash. Tree pushers clear a field by pushing the trees over and pulling the roots out of the ground. What is left after clearing is an area of no roots, little litter, and a highly disturbed broken soil surface. On such a site there is severe runoff and erosion with almost 70 times the amount of runoff and a loss of 1700 times the soil as the same area under traditional clearing.

SHIFTING CULTIVATION

Estimates of the actual number of shifting cultivators vary from 250 million (Myers 1986) to 300 million (Russell 1988). In a world of 5 billion it might appear to be of no great concern how 5% of the population makes its living. But what cannot be ignored is the distribution of shifting cultivators and the large area under these agroforestry systems. Shifting cultivation is the most widespread type of tropical soil management technique. Various types of shifting cultivation are currently practiced on 30% of the world's exploitable soils (Hauck 1974, Sanchez 1976: 346).

What is shifting cultivation? There are various definitions of shifting cultivation. The most commonly used defines shifting cultivation as any agricultural system in which the fields are cleared (usually by fire) and cultivated for shorter periods than they are fallowed (Conklin 1957). With the development of the agroecosystem approach and its holistic view of agricultural systems as part of the greater "natural ecosystem," there has been a reconceptualization of shifting cultivation. The agroecosystem approach attempts to integrate "the multiplicity of factors affecting cropping systems" (Gliessman 1985: 18). Whereas many earlier studies described the swidden system as inherently stable and provided a checklist of attributes, more recent work based on an agroecosystem approach has stressed swidden/fallow as part of an overall subsistence strategy, flexibly responding to stress as the social, economic or natural environments change (Gliessman 1985, Altieri et al 1973).

Reflecting this dynamic view, a more recent definition of shifting cultivation is "a strategy of resource management in which fields are shifted in order to exploit the energy and nutrient capital of the natural vegetation-soil complex of the future site" (McGrath 1987: 223). The emphasis on strategy and agroecosystem dynamics makes shifting cultivation "neither a static nor necessarily stable system of agriculture" but one that is flexible in response to change (McGrath 1987: 223).

Viewing shifting cultivation as a strategy that can be flexible in response to change places shifting cultivation on a continuum with other agricultural systems (which may differ from it in the length of the fallow period, the length of the cropping period, management techniques, etc.) with a movement from one agricultural system to another occurring as a response to changing conditions (Beckerman 1987; Boserup 1965; Raintree and Warner 1986).

As a subsistence strategy, shifting cultivation has not been popular with many governments and international agencies. It is commonly regarded as a waste of land and human resources as well as being a major cause of soil erosion and deterioration. To clear a forest, use the swidden field for a year or two, and then move on to another patch of the forest does indeed seem wasteful if the forest is perceived in terms of timber values alone (Grinnell 1977; Arca 1987). At the heart of the matter is not the *cutting* of the forest, which foresters do all the time, but the *burning* of the trees. The concern is not the maintenance (non-disturbance) of the forest so much as who should benefit from its demise. Governments perceive the burning as a misappropriation of resources from the national to the most local (small farmer) level.

Who are the shifting cultivators? In Africa, shifting cultivation is practiced by farmers throughout the humid zone. However, long fallow shifting cultivation has been gradually replaced by intensively used fields close to the home site and long-term rotationally fallowed fields further away (Chidumayo 1987; Getahun et al 1982). Although there is some variation in the actual management practices, crops grown, etc., this intensification of shifting cultivation is occurring throughout the region.

Unlike Sub-Saharan Africa, where everyone belongs to a tribe, in Asia and Latin America the long fallow shifting cultivators have traditionally been ethnic minorities with their own language, religion, values and, in some instances, crops. The government perception of shifting cultivation as a land use system is intricately tied to it being practiced by those who are "outside" the mainstream culture of the country. People who are viewed as being "primitive" since they have a simpler, or merely different, material culture, are also perceived as practicing a "primitive" agriculture, wasteful of resources that could be better utilized by the national "mainstream".

This prejudice has discouraged the emergence of a more objective view of shifting cultivation in many countries. Thus, a land use system becomes judged on the basis of *who* is practicing it, rather than on its own merits and limitations. In Asia and Latin America the perception of shifting cultivation is further complicated by

the fact that it is currently being utilized not just by the "tribos" (tribal minority) or "indos"(local populations), but also by the landless peasant and the frontier migrant. Again, there is indifference, at best, concerning what low status groups are doing, unless it is judged as infringing on the national resources. Both the peasant and the tribos might be perceived as being shifting cultivators, but their respective land use systems are radically different.

The tribos are usually practicing *integral* swidden, a land use system based on "a more traditional, year-round, community-wide, largely self-contained, and ritually sanctioned way of life." When integral swiddeners enter a new area as *pioneers* significant portions of climax vegetation may be cleared each year. When the community is well established and little or no climax vegetation is cleared annually they are practicing *established* integral swidden (Conklin 1957: 2, 3).

The peasants are practicing *partial* swidden, which, rather than being based on a way of life, reflects "predominantly only the economic interests of its participants" (Conklin 1957: 2). Peasants practicing partial swidden have strong sociocultural ties outside the immediate swidden area and their goals in terms of ownership and productivity differ from the integral swiddener. Rather than being part of a stable community that has historical and cultural ties to the area the partial swiddener may be there only for the purpose of obtaining a crop for a year or two. Such partial swiddeners are primarily permanent field cultivators who make a swidden in addition to cropping permanent fields. In these cases the partial swiddener is practicing *supplementary* swidden and uses the swidden to supplement the permanent field. A common pattern in Southeast Asia is for the permanent field to be in the valleys and the swidden fields on the hillsides. Another partial swidden system occurs when the cultivator migrates into the forest. Often with little prior knowledge of swidden techniques, this swiddener devotes all his agricultural efforts to making a swidden. This partial swiddener is making an *incipient* swidden, but in most instances does not have the knowledge to develop a swidden system that can be sustained (Conklin 1957: 3).

These distinctions have been used extensively in the literature, although there is a tendency, especially in South America, to confuse *incipient* with *pioneer* swidden. Rather than use the term pioneer as it was originally developed (a tribal *integral* swidden community becoming established in a new area), the term pioneer swidden is incorrectly used to refer to the swidden practices of *peasant migrants* who move into the forest, swidden, and later abandon or sell a degraded field and/or establish permanent field cultivation (UNESCO/UNEP 1978: 324; Moran 1987). According to Conklin's original definitions these peasant migrants are not pioneer swiddeners, but *incipient* swiddeners who degrade because they do not have enough knowledge of the forest ecosystem to do otherwise. Nevertheless, since it has become in recent years the most common usage, for the remainder of this note *pioneer* swidden will be used to distinguish the practices of migrants from the *integral* swidden of established, self-contained communities.

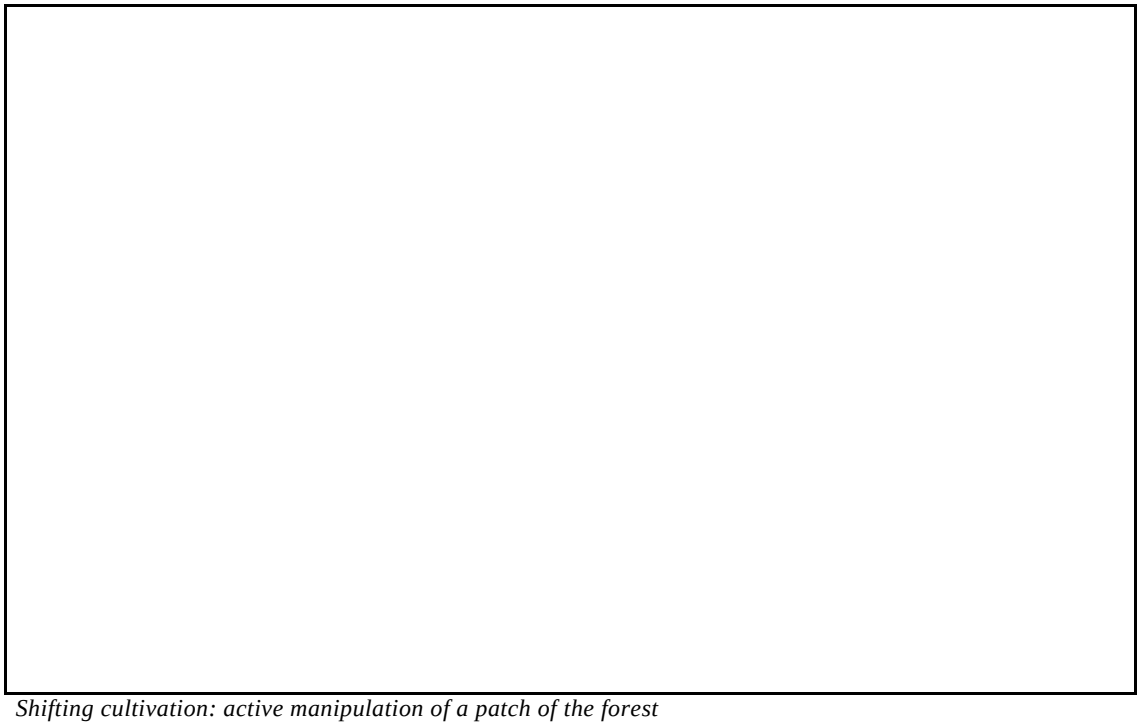
With reference to the millions of shifting cultivators mentioned above, it can now be asked how many are pioneer and how many are integral swiddeners? Unfortunately, many governments do not make a distinction between swiddeners as to which are pioneer and which are integral (also referred to as traditional). Since the two swidden systems have very different impacts on the environment, this distinction should be made (Watters 1971). When destruction of the tropical forest occurs, it is the pioneer, not the integral swiddener, who is usually the cause. "Land hungry" migrants, without a background of integral swidden that would give them the knowledge to manage the forest ecosystem, are entering, farming and degrading the forested areas (Olafson 1981: 3; see also Moran 1987: 227; Moran 1983; Watters 1971). A population that resides in an area for one or more generations will have a far more precise knowledge of the local environment than the "dislocated" migrant, who is far more likely to practice a pioneer system, using agricultural methods from the area of origin rather than those suited to the area of resettlement (Moran 1987: 227).

Chapter 2

Shifting cultivation as a resource management strategy for the tropics

The counter-argument to the position that "swidden is wasteful and causes environmental degradation" is that shifting cultivation appears to be the most effective method for dealing with the ecological realities of the tropical forest (Cox and Atkins 1979). Historically, shifting cultivation has not been limited to the tropics. From the Neolithic on it has been used by agricultural communities throughout the world when confronted by forests. As early agriculturalists moved through Asia, Europe, Africa and the Americas, the forests were cleared and fields appeared. Until very recently swidden was still in use in the spruce pine forest of northern Europe (Cox and Atkins 1979; Russell 1968; Ruddle and Manshard 1981). It continues in the tropics because of the environmental limitations of the region.

Shifting cultivation represents a response to the difficulties of establishing an agroecosystem in the tropical forest. The tropical forest ecosystem is characterized by generally poor but varied soils and extremely diverse flora and fauna, providing few nutrients, but many potential competitor species for food crops. By cutting the forest and burning the felled trees and litter, the swiddener makes use of an "artificial energy pulse" that eliminates competitor species and concentrates nutrients "in order to briefly . . . transfer the energy flow into food crops" (Odum 1971; also Bodley 1976). It is an active manipulation of a patch of the forest and conversion to a more open and useful succession for the cultivator (Rambo 1981: 36; see also Olafson 1983: 153).



Shifting cultivation: active manipulation of a patch of the forest

With integral swiddeners, however, it is only a temporary intervention in the forest ecosystem. Natural succession begins again, and in many instances swidden practices actively aid in the eventual reestablishment of the forest (Odum 1971; Bodley 1976; Denevan and Padoch 1988a). The form of shifting cultivation practiced by integral swiddeners does not destroy the forest forever; rather, it replaces it with a successional series of regrowth that for the swiddener is more productive than the original forest (FAO 1978).

By having different sites in different areas in different stages of regrowth a variety of ecozones are created (Nations and Nigh 1978). A mixture of crops are harvested and wild plants collected and, since the greatest wildlife potential occurs where there is the greatest diversity of habitats, hunting is improved (UNESCO/UNEP 1978:461). If crop failure occurs, the forest and the created ecozones serve as a famine reserve (Warner 1981; Nations and Nigh 1978).

The strategy of swiddeners makes sense in terms of game theory, for as decision makers they determine how much labour to put into each of the various subsystems so as to receive the best " 'pay-off' under given circumstances" (Smith 1972: 421-22). It is because they utilize more than just the agricultural subsystem that shifting cultivators are sometimes perceived as being "part-time" agriculturalists; in fact they also hunt, fish and gather wild produce for market (FAO 1970). This multi-niche strategy, combining agriculture with hunting, fishing and gathering, with labour being invested as needed, creates an agroecosystem that can be highly productive, stable and sustainable. If one subsystem fails, the utilization of another subsystem can be intensified to provide sufficient food (Warner 1981). In some instances, if the agricultural subsystem loses its reliability because of land shortage or degradation, fishing and gathering may become the central focus of subsistence activities (see Nietschmann 1973).

SWIDDEN AND TROPICAL SOILS

As more has been learned about tropical soils there has been a growing appreciation of shifting cultivation as representing "ingenious adaptations to unfavourable environments, based on a remarkably complete knowledge of local ecology and soil potential" (Allan 1972a: 217). Acid tropical soils account for one billion hectares of land around the world. Of the one billion, 700 million hectares are in the humid tropics, 300 million hectares are in the savanna, and almost all of this is in the developing world (IBSRAM 1987). The humid tropical environment of the shifting cultivator is one of acid soils.

Effective techniques to restore soil fertility are "the pivot of every system of agriculture", and the swiddeners of the tropics have developed a technique that works -- the use and maintenance of the forest to restore soil fertility (Benneh 1972: 235). Recognizing that it is the living vegetation that provides the nutrients to support the crop, the integral swiddener shows a marked preference for field sites with standing mature forest, either "primary" or well established "secondary" (Dove 1983a; Allan 1965; Rambo 1981a; Rambo 1983; Posey 1983). After a burn the nutrients available to the food crops increase, but then quickly start to drop, probably because of leaching and erosion (Andriesse 1977:12-13; Nye and Greenland 1960 and 1964). Nye and Greenland (1964: 102) found the soil within the swidden extremely heterogeneous because of fallen timber, termite mounds and irregular distribution of ash following the burning. These variations will form the microsites that are planted with different crops according to the swiddeners knowledge of which would benefit from rich soils and which would not be affected by poor soils. After the cropping cycle is finished (usually 1 - 4 years) the field is left fallow, although tree crops may continue to be harvested for years. If left long enough the site will recover its fertility; if the site is used too soon, degradation can begin.

It may be difficult to recognize degradation, especially if it is occurring gradually, perhaps over several generations. With swiddeners it is especially difficult since they "appear to be so self-sustaining, so well integrated with their environment" (Street 1969: 106).

In a study that attempted to correlate field usage with soil fertility, frequency of use had a major effect on soil fertility. Arnason *et al.* (1982) studied two Maya fields, both with the same crop complex (maize as the staple crop planted). One had been under shifting cultivation for 100 years with a fallow period of 5-15 years. The other field had not been used for 50 years. On the field that had been fallowed for 50 years, the yields were twice as high. Phosphorus was suggested as the limiting nutrient. It is interesting to note that the fields are left to fallow after three years by the swiddeners in Arnason's study not because of the recognition of phosphorus loss, but because of the increase in labour needed for weeding.

The implication is that the longer the fallow the better for soil recovery. If long fallows can be maintained, the system should be sustainable. Soil replenishment by fallowing is a response by swiddeners to the need to produce food without recourse to manures, fertilizer or alluvial deposition (Greenland 1974: 5). If long fallow is maintained, the system works; if the fallow period shortens, the soil fertility declines (see Figure 1).

Figure 1. Model of tropical forest ecosystem dynamics with swidden

MOBILITY AND FOREST MAINTENANCE

The forest is not only needed and therefore preserved for future fields, but also for gathered food, game, building materials, medicinal plants, etc. -- any or all of which might show degradation or decline before fallow periods grow too short for adequate soil replenishment.

The swiddener's response to a degrading agroecosystem is to move. This is not to suggest that they are indeed the "nomads" of former belief. There is great variation among swiddeners as to their degree of mobility. Some groups cut the forest in the tradition of Conklin's integral pioneers and move on to new village sites often (Kunstadter and Chapman 1978); others may live in permanent villages and make annual treks through the forest at great distances from their villages for hunting (see Posey 1983; 1985). Since the village sizes are usually small (50-250 people) and dispersed, population densities remain low (Harris 1972; 1973). If the population does not increase, most groups can and do stay within a small area for long periods of time, or until their land area is diminished by the fallowing areas being classified as forest reserves or timber concessions.

However it is not unusual for individuals, families and, in some instances, entire villages to move for other than economic reasons. In some societies men move out of their natal area to another hamlet to find a wife and settle there (Warner 1981) or go on journeys that last for years (Dove 1983). Families may move between hamlets or villages to escape interpersonal tensions or engage in extended visits with relatives. Houses, even villages, may be abandoned if there have been deaths. And in the present day, many people may find themselves designated by external agencies (usually the government or a commercial enterprise) for resettlement.

VARIATION IN SWIDDEN SYSTEMS

Even within the same regions swidden agroecosystems vary in the emphasis placed on different subsistence subsystems. In some swidden systems fishing is important, in others gathering; homegardens might range from highly productive to virtually non-existent. Although there is subsystem variation in swidden systems, all share the strategy of having potential subsystems that can be intensified as needed. These subsystems may only be utilized when other subsystems fail. Gathering from the forest is a common subsystem, but the intensity of the gathering can vary as needed. If the cultigen (cultivated crops) harvest is good, the food gathered from the forest may be restricted to specially favoured fruits, vegetables or "snacks". But if the cultigen harvest is inadequate, gathering can be intensified to include staples (wild roots, sago, etc.), as well as more fruit and vegetables to support the group until the next cultigen harvest (Warner 1981).

The combination of strategic variability and response to the biological, physical and socio-cultural environment creates a wide array of potential swidden agroecosystems. Swiddeners can plant root crops or seed crops or both; fields may be used for 1 - 4 years and have planted fallow or be left with a few root crops remaining; fields may be left to rest for 5, 10, 25 years or virtually forever; fields may range in size from barely a tenth of a hectare to many hectares and be dispersed or contiguous; swidden fields may be used to supplement hunting and fishing, or for supplementary crop production by farmers whose main concern is their permanent fields. This variety and flexibility is the strength of the swidden agroecosystem (Ruddle and Manshard 1981: 74).

MAINTENANCE OF THE AGROECOSYSTEM

In order to survive, the tropical forest has to make use of the nutrients available in the biotic community. This is the same strategy used by swiddeners. The swidden creates a system of "accelerated decay" that replicates the general sequence of nutrient flow in a tropical forest. Instead of relying on the natural decay of the tropical forest to provide nutrients, the swiddener "accelerates natural decay by the burning of the slashed and felled fields". Because the accelerated decay is less efficient than the natural decay and there is great energy loss, fields quickly decline in fertility (Ruddle and Manshard 1981: 75). To regain their fertility, field sites must be left fallow.

Shifting/fallow cultivation is ecologically sound if forest fallows can be maintained (Moran 1981: 54). Forest fallow, also called "long fallow", is attained when the cleared and planted field is left to regenerate to "high" forest. Traditionally, it was the most common form of swidden in use in the humid tropics by integral swiddeners. If fields are small, the sites, like naturally occurring forest gaps, can "rapidly heal" and regeneration occurs swiftly. The surrounding forest serves as a seed source for the site, as well as protecting it (as it did the swidden field) from winds and erosion (UNESCO/UNEP 1978: 476). Rainforest species are unable to regenerate

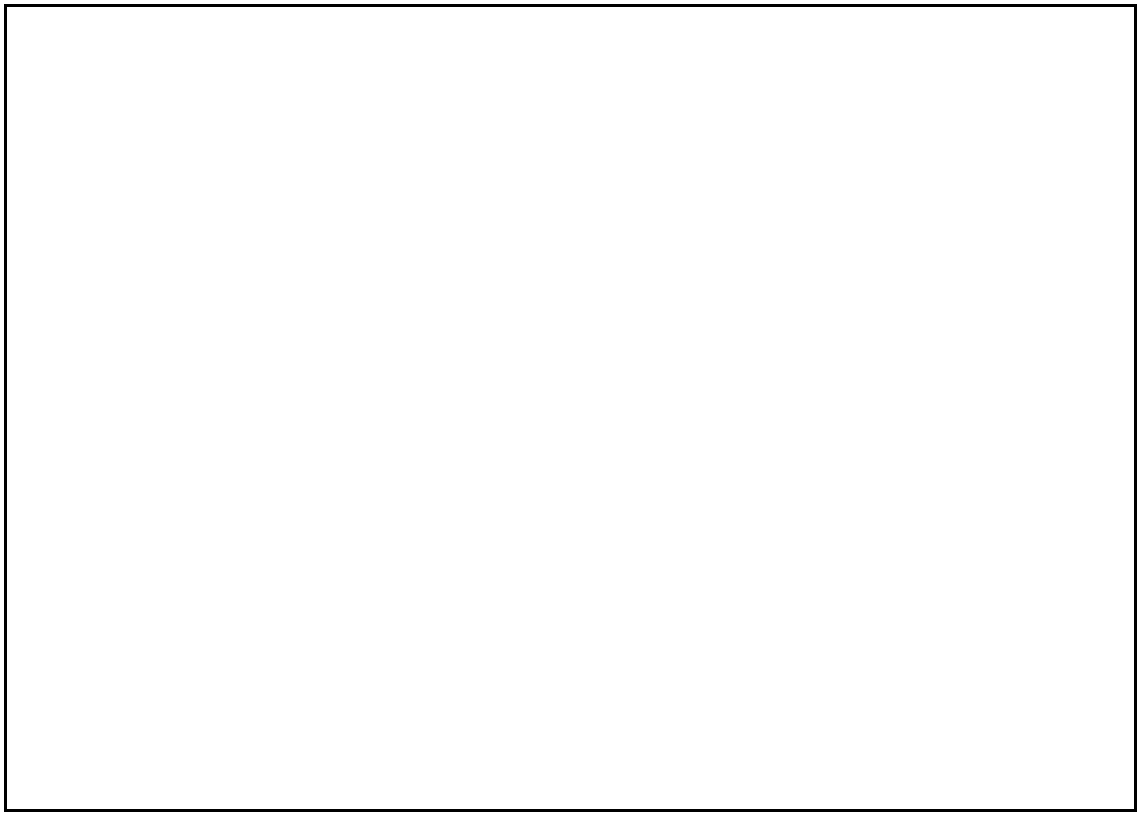
outside of the forest. By having small fields and retaining "pieces of the original forest" for reseeding the integral swiddener is actively managing the regeneration of the forest (Clarke 1976: 250; Gomez Poma *et al.* 1972).

The swiddener also uses other techniques of management that favour forest regrowth. While the field is under crops, many swidden groups practice "selective weeding". Herbaceous plants and shrubs that will become part of the desired succession may be cut back, rather than uprooted, and once harvesting of cultigens declines, allowed to regrow. Rather than being cut and burned, trees may just be cut back, so that they will resprout and become part of the succession. Trees that are especially valued may be protected and not cut at all. Having plants and trees already established allows a rapid regeneration of the forest. The swiddener does not have the compulsion to maintain a "clean" field with large patches of exposed soil. Just the contrary, in fact, for it is recognized that uncovered soils are soils that will wash or blow away (Clarke 1976; Ruddle and Manshard 1981). A swidden field is a field not of rows, but of filled spaces.

Ecosystem maintenance creates different stages of regrowth that provide a more diverse array of ecozones for animals. Since secondary forests have a higher carrying capacity for wild animals than primary forests, an anthropogenically created and managed forest improves the subsystem of hunting and strengthens the agroecosystem (Vos 1978: 16, see also Peterson 1981).

Swidden as a form of forest

Long fallow swidden recreates the diversity, complexity and use of the biomass for nutrients that existed in the forest. The term *alternative forest-like structures* (AFS) has been used to describe the "resonance" between the forest and the swidden field. Swiddeners actively recreate the forest in their fields so as to "preserve with some stability the analogical relationships between the cultivation cycle and the natural cycle, and to replace the wild species by domesticated ones that fill the same 'functional and structural niches as their wild precedents' " (Olafson 1983: 153 citing Oldeman 1981: 81). In some swidden groups the boundary between forest and fields may blur, as forest species are planted in the swidden and domesticated species in the forest (Olafson 1983: 155 citing Schlegel 1979).



Farmers are aware of the continuing need to match available varieties to the microsites in their fields.

This interpretation of the swidden nicely meshes with agroecosystem analysis, where agriculture is not seen as a system that is separate from the ecosystem of which it is a part. If swidden is a reflection of the forest, it then fulfills the major requirement of being a *good* agroecosystem since the swidden manager takes into consideration the local biology and attempts to disturb it as little as possible while permitting its periodic reestablishment (Janzen 1975: 54). The integral swiddener changes "selected items of its content" but maintains the "gross pattern" of the forest, and therefore is different from the other users of natural resources who change "generalized biotic communities into more specialized ones" (Ruddle and Manshard 1981: 75). In a difficult environment, the long fallow swiddener has been able to develop an agroecosystem that maintains its natural resource base and achieves sustainability.

Rather than define swidden by listing traits, crops and methods, it is more useful to perceive swidden as a set of strategies for an agroecosystem that evolved in response to environmental conditions. Diversity is highly valued since farmers are aware of the continuing need to match the available varieties to the microsites in their fields. Genetic diversity is maintained by a mixture of natural selection and human preference. Natural selection determines which varieties do well in a damp place, a steep place, a wet year, a dry year, etc. Human preference intervenes through decisions as to which varieties to keep for seed, and which to discontinue.

Farmers are experimenters. Different varieties of crops, as well as new crops, are tested and tried in different conditions (Johnson 1972; Manner 1981; Warner 1981). The risk involved is such that experimentation is usually small and only a small component of the agroecosystem is involved, e.g., a small portion of a field is planted in a new crop, or a new variety of a familiar crop is planted in addition to, not in place of, the better known varieties. Forest analogies aside, although a single crop or variety of crop in a field of high diversity might not have as high a yield as it would if planted as a monocrop, the diversity of varieties and crops create a system where even if some crops are attacked by pest or disease, others will survive (Manner 1981).

Multifields

Diversity exists not only in varieties and crops, but also in the number of fields. It is common to have fields from previous years in production and a new field in preparation. If, as in the Amazon, the system is based on perennials with new fields being made each year, it is possible to have many fields each in a different stage of succession (Denevan *et al.* 1984). From the perspective of a swidden household there are a wide range of options from which to choose in order to obtain the desired level of diversity. There can be a number of separate fields each with a different cropping pattern -- some fields may be monocropped, others extremely diverse, or there may be a system of monocropped swidden fields with diverse homegardens (Eden 1988).

A household having more than one field in different microenvironments is another way of maximizing diversity and options, as is the practice of having one field cut from secondary forest and another from primary (Warner 1981, Dove 1983). Each field may be small, but by having small fields in different areas a family spreads out subsistence risk in order to minimize "possible crop loss due to flooding, animal pests, and diseases" (Nietschmann 1976: 145). If animals destroy one field, they may not another; if floods wash out one field, another may survive to harvest.

In Africa, rotational bush fallowing is usually a multifield system. There are home fields and "out" or "far" fields. Out fields are the fields that are further from the compound. They are traditionally cropped for a brief phase and then fallowed for many years. Fallow exceeds cropping period. Home fields are closer to the compound and tend to be cropped for longer periods with shorter fallow periods; in some areas they become intensive homegardens. In addition, there is the use of small "wet" areas for dry season fields, and "old house sites, which have a higher than average level of fertility," for more demanding crops (Greenland 1974: 7).

The more diverse and broad-based the swidden agroecosystem, the greater the stability. Through a combination of different crops, different varieties and different fields, the swiddener strives to develop the most stable and sustainable system in order to provide nutritional security.

AGROECOSYSTEM DYNAMICS: THE DEVELOPMENT OF A LOCAL FARMING SYSTEM

Integral shifting cultivators in the humid tropics are tribal people. In the Amazon and Southeast Asia this puts the swiddener at a disadvantage since tribal people are minorities in these regions and usually do not have political power nor secure land tenure. They are commonly perceived as being primitive, destructive, and a hindrance to development. In Africa, everyone belongs to a tribe, although particular tribes might be more or less powerful on a national level. To belong to a tribe in Africa is to be part, rather than apart, of the social organization mainstream. Land tenure rights vary depending on previous colonial experience or current land adjudication but, in general, unlike counterparts in Southeast Asia or the Amazon, African farmers in tribal areas will have had in the past, if not in the future, fairly secure usufruct if not ownership of land.

In all three regions shifting cultivators are practicing a traditional farming system. This refers to local systems that "use local products and local techniques," have "roots in the past" and have "evolved to their present state as a result of the interaction of cultural and environmental conditions of a region" (Gleissman 1985: 57). The implication is that a traditional farmer is a member of a community that has resided in a region for many years (at least long enough for an agroecosystem to have developed) and uses local resources rather than imported inputs (Padoch and de Jong 1987:179, Padoch and Vayda 1983, Wilken 1973).

Local adaptation does not make the farmer non-innovative and tied to unchanging methods "derived from individual and social experience" (Wilken 1973). Such an interpretation overlooks, especially with shifting cultivators, the dynamism of a community's adaptation to its environment. Reliance on local materials, energy sources, and the technical knowledge of the community does not imply a lack of willingness to try something new (Padoch and de Jong 1987: 179). Certainly no "traditional agricultural community" is today doing precisely what it was doing a generation ago. A stable community is not a static one, but one that is able to adapt to new conditions. Change need not weaken such a community. In some instances, such as the introduction of new crops, change can improve the procurement systems and increase the stability of the community.

Development of the tropical crop repertoire

New crops have moved into all the regions of the world. For the humid tropics a period commonly used as a point of reference is 1500 A.D. when contact between the Americas and the Old World began. At this time in South America the primary domesticated staple crops were manioc, maize, sweet potato, potato (in the highlands); in Central America there was maize, usually grown with beans and squash. In this region prior to 1500 there had been movement of maize to the north and south, cassava to the north and into the Caribbean. In Africa there were yams in the humid areas, indigenous rice, millet and sorghum, and in some regions plantains and bananas (originally from S. E. Asia). In Southeast Asia the main domesticate was rice, but there was also millet, sorghum, cocoyam, plantains and bananas. This list represents only the main staples and excludes other crops such as the various pulses, vegetables, spices, etc., that were diffused far from the area of their origin by 1500. It was the farmers who moved these crops around.

A look at what the shifting cultivator of today is planting in the swidden reveals a remarkable willingness to innovate and experiment. Manioc remains the staple in the Amazon area for most groups, but maize, plantains and bananas (which have replaced manioc as the main staple for some groups), cocoyam and rice are grown as well. In Southeast Asia rice continues as the favoured staple, but millet and sorghum have declined, and maize (which has become the main staple in some regions), cassava, yams, and sweet potatoes are grown throughout the region. In Africa maize, manioc, sweet potatoes, cocoyam, and the further diffusion of plantains and bananas have replaced many of the "traditional" crops or lessened their importance.

This diffusion of plants throughout the world has allowed a farmer in an isolated community to become part of the world-wide transformation of cropping systems. It expanded the repertoire of plants and created the potential for a better fit of crops and microsites within the field. It also, in many regions, expanded the amount of potential arable land; land that was too wet, too dry, or too infertile for indigenous plants could now be

planted with new crops that would do well in those conditions. In some areas, the higher productivity of introduced crops allowed the restructuring of household labour toward new economic activities or, as in Africa, helped offset the labor shortages that resulted from male outmigration. The addition of new crops to shifting cultivation systems allowed the farmer to become more productive and the agroecosystem more stable and sustainable, as it further adapted to microenvironmental and microsite variation.



Family shredding cassava roots to make flour (Vietnam)

Use of natural process

Although the different swidden groups might explain it differently within their own cultural context, the use of natural process is evident throughout the tropics. The shifting cultivator recognizes that the natural *processes* of the tropics can be utilized as a natural resource. Indigenous resource management is based on maintaining "specific natural processes in order to have specific items" as an outcome of these processes (Alcorn 1989: 64). Rather than expend large amounts of energy to eradicate or override the natural process, the tropical farmer uses the naturally available process for his own ends. Unlike his temperate climate counterpart, the tropical farmer does not have the means to override the natural processes of his environment. Tropical technical knowledge revolves around how to operate *with*, rather than try to *overcome*, the natural processes associated with the year-round growing season and rapid succession that result from the high rainfall and high temperatures of the region (Alcorn 1989:69).

Natural processes extend beyond a single agricultural season, and so does the environmental perception of the tropical swiddener. The perception of agricultural succession goes beyond the season and into the next generation as the natural process of regrowth takes place aided and manipulated by the farmer. This manipulation has created anthropogenic forests throughout the tropics (see Balée 1989, also Jorgensen 1978).

This is not to imply that a swiddener could sit down and explain the process of succession or forest ecology and the flow of nutrients in the tropical forest. The individual's knowledge might be encoded in religious belief (e.g., the belief that spirits would get angry if certain things are or are not done), analogy (e.g., the forest is like a parent), or scientifically inaccurate assessments (e.g., seeds will not grow if a certain bird sings). The specific explanation might have no meaning outside the particular culture. But the knowledge system works. Whether it is encoded in religion or myth is not important. What is important is that shifting cultivators understand and use the natural processes of the humid tropics to maintain, not degrade, their resource base.

Chapter 3

The swidden/fallow system

OVERVIEW: VARIATION AND SIMILARITY

Although the focus of this paper is on shifting cultivation in the humid tropics it should be recognized that within this broad regional classification there are differences in climate, terrain, population, and historical background that have had a great impact on the existing swidden agroecological systems.



Within the humid tropics there are regional differences that have had great impact on the existing swidden systems.

Climate

The Amazon basin is one of the wettest regions of the world. About half of the rainfall is generated by the recycling of water within the region, with the remainder having as its source the Atlantic Ocean. The rate of precipitation generally increases from east to west, with the highest rainfall occurring in June north of the equator and January to the south (Hame and Vickers 1983). The Congo Basin is drier; even at its center a "dry season" can occur that lasts up to two months, with rainfall on the periphery of the basin being especially unreliable at the beginning and end of the rainy season (Miracle 1973, Kowal and Kassan 1978).

Unlike the contained basin of the Amazon, Southeast Asia is a sprawling area of ocean, islands, and mainland hills and valleys. About half the land area is continental (Burma, Thailand, Vietnam, Laos, Cambodia,

Singapore, and peninsular Malaysia), and the other half is insular (Indonesia, the Philippines, Brunei, Sabah, and Sarawak). The rainfall pattern of Southeast Asia falls into two broad categories: nearly even distribution of rain year round (Malay peninsula, Borneo, Sumatra, West Java, the Moluccas, and the eastern Philippines) and the more common monsoon pattern of a season of heavy rains with a definite dry season (peninsular Thailand, coastal Burma, Kampuchea, Sulawesi and the western Philippines). The driest areas typically receive less than 1500 mm. of rainfall per year (Capistrano and Marten 1989). As is common in island and mountain areas, within a climatic boundary there can be variability from year to year and from site to site. These local climatic deviations from the regional averages create different microenvironments. Microenvironments resulting from the variation of the rain are further differentiated by the localization of soils, forest and riverine/sea resources (Warner 1981).

Terrain

Unlike the Amazon basin and Africa, the terrain of the swiddener throughout Southeast Asia is one of hills and valleys. Heavy rainfall combined with this terrain makes hillsides difficult for intensive agriculture, with erosion easily occurring at the cost of the hills but to the benefit of the lowlands, where fertile alluvial soils form the basis for wet-rice culture in the region (Capistrano and Marten 1986).

Population

Population densities in the Amazon basin are low. The indigenous populations throughout the Americas were decimated by Old World diseases at the time of contact. In the Amazon the initial epidemics were followed by the persecution and disenfranchisement of many of the indigenous groups. In response to these pressures there was a movement by some survivors away from contact into the inaccessible areas within the forest. "Detribalization" of areas also occurred, where the residents were ancestrally tribal but were no longer practicing their indigenous customs or part of an identifiable group. Scattered populations were brought together by the Christian missions and resettled (Roosevelt 1989).

The low population densities currently found in the tribal areas are more reflective of the effect of these pandemics and persecutions of the past than of the carrying capacity of the Amazonian indigenous agroecosystems. What knowledge was lost with the pandemics of the past and the persecution that has continued to the present? This is difficult to assess. In small societies, although there may be people who are recognized as knowing more than others about plants, animals, medicines, ritual, etc., everyone knows enough to do all of the basic tasks of a man or woman in the society. The more authoritative knowledge might be lost, but the everyday "know how" remains. In studies of Amazonian peoples it appears that their indigenous knowledge is certainly complete enough to allow them to develop and maintain a diversity of procurement activities.

As in the Amazon basin, areas of Africa in the past experienced depopulation as a result of contact with the West. The slave trade played a similar role in Africa as did the Old World diseases introduced to the New World. Currently, however, Africa has the highest intrinsic growth rate in the humid tropics (2.6%). Indigenous beliefs and marital patterns that favoured large families in the past are still strong enough today to encourage a large number of offspring. The continuation of high fertility, with a cessation of deaths due to inter-tribal warfare and raiding and the growing availability of modern medical services, has led to the increase in population growth rates. The high growth rate exerts pressure on the traditional field rotation systems (Pieri 1987). It is a problem not so much of numbers of people, but of how quickly the numbers are increasing. If a village doubles its population within a generation, there may not be enough land to continue the existing rotation system, nor can the traditional means (such as open aggression against another tribe) be utilized to acquire more land.

In Southeast Asia population densities vary greatly in the region depending on urbanization and land use systems. Current swidden population densities range from a low of 12 persons per km^2 (northern Laos) to 35 per km^2 (northern Thailand) (Boklin 1989, Kunstadter 1978b). As with their Amazonian counterparts, integral swidden is being practiced by the tribos, the tribal people, of Southeast Asia. Culturally, linguistically, and religiously different from peasant "lowland" society, they have little political power and are regarded as being inferior. Usually swiddeners are perceived as "squatters" rather than "owners" and disputes between logging operations, migrants, and swiddeners are increasing. The response to in-migrating population pressure on resources has been out-migration, wage labour and, when feasible, agricultural intensification.

Settlement pattern

Although there are exceptions, indigenous Amazonians and Southeast Asians are predominantly village people. They live in small settlements, rather than in individual homesteads. Although a family may spend a period of the agricultural cycle in a temporary house on the swidden field, their primary residence will be in a settlement.

In Africa individual homesteads can assume the characteristics of a village. A polygynous household with several wives, married sons and their wives may become a village in size and function.

The settlement site of the village itself may be chosen by criteria other than the quality of nearby agricultural land. Throughout the tropics, in an area where there are several ecological zones (mountains, forest, grasslands, flooded areas) a village may be sited in a transitional zone that provides access to each ecological zone and its resources (Posey 1983).

In areas of the Amazon where there is one dominant ecological zone, criteria used in making a decision for a site for a village are concerned with community well-being: raw materials for rituals, plentiful game and/or fish, good visibility to avoid surprise raids, and availability of water. These criteria may take precedence over the inherent fertility of the soils near the proposed village site, not because of ignorance of soils, but rather because of the utilization of manioc, the staple crop of many groups in the Amazon (Moran 1989). Manioc is well adapted to tropical soils and will grow in soils that are nutrient deficient, acidic, and contain high levels of aluminum toxins. The tolerance of manioc for poor soils allows other criteria to be used for village sites.

Both in mainland and island Southeast Asia, swiddeners are predominately hill people, making use of the slopes for good drainage for their fields. As the Amazon and Africa demonstrate, swidden is not tied to a hilly terrain. The dichotomy of hill and valley, swiddener and padi farmer, that exists in Southeast Asia is the result of historical factors rather than agronomic principles. Swiddeners have been pushed into the hills away from the valleys by later arrivals to their areas. They have adapted to the hillside and have identified the hills as their agroecological site. On the mainland, integral swiddeners favour small river valleys for residence. Although the inner islands of Indonesia are currently farmed by permanent field farmers, integral swiddeners live on many of the other islands of Southeast Asia and are the predominant populations in parts of Sumatra, Sabah and Sarawak.

Household autonomy in decision making

Throughout the humid tropics the general pattern is for each family to be responsible for its own field. Whether living in longhouses, individual houses, or villages in which a shaman or elder selects the block of forest that the village will use in a particular year for swidden, each household has the autonomy to make decisions concerning crops, labour and microsite utilization. Even if, as in Southeast Asia, there are communal regulations concerning irrigated terraces, swidden fields are regarded as being individually owned and managed (Prill-Britt 1986). However, while swiddeners are usually more loosely organized than their peasant counterparts, highly structured communities do occur. For example, the agricultural schedule of the Lua' and Karen of northern Thailand is tightly regulated by the shaman-elders, who decide which areas of the managed forest reserve will be cut for swidden, when it will be cut, and when it will be burned (Kunstadter 1978c, Keen n.d.). However what appears to be more common is for the village or hamlet leader(s) to have authority to settle interpersonal disputes, while agricultural activities, unless they infringe on the rights of others, are the concern of the individual household (Weinstock 1986).

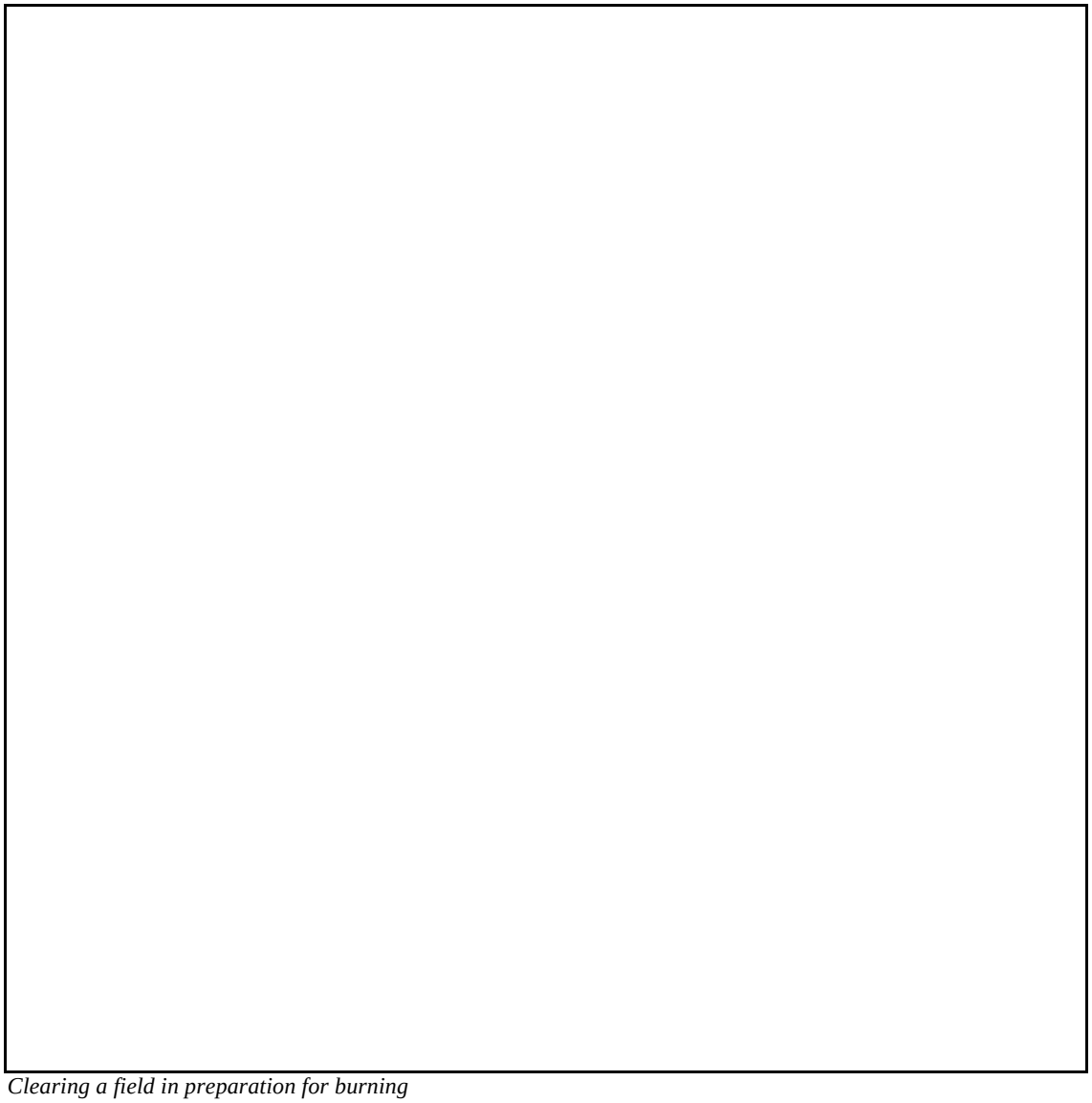
The swidden household, therefore, has to make a series of decisions concerning the management of the agricultural component of the agroecosystem. These decisions are guided by the resources available, the individual's knowledge of how to make use of these resources, the rules and preferences pertaining to residence, the religious beliefs and sanctions of the society, and the labour resources available within the household.

THE SWIDDEN/FALLOW CYCLE

There are six stages in the swidden cycle at which the swiddener is required to make crucial decisions concerning location, scheduling, crops, and labour inputs: site selection and clearing, burning, planting, weeding and protecting, harvesting, and succession. A poor decision at any of these stages might well mean smaller harvests, or perhaps no harvest at all.

Site selection and clearing

Given the goal of diversity, how do swiddeners choose their fields? An integral swiddener usually has the right to make the field anywhere in the forest. Rights to returns from labour are recognized, so a family "owns" the harvest of its fields. In Southeast Asia and the Amazon, sharing of food occurs within the settlement and is encouraged, but the harvest "belongs" to those who clear and maintain the field. Since the potential field can be, theoretically, anywhere in the forest, site selection operates within minimal constraints on availability of potential sites. From the swiddener's viewpoint s/he is surrounded by thousands of hectares of forest, all of which at the initial stage of decision making are potential fields.



Clearing a field in preparation for burning

A swiddener in the humid zones of Southeast Asia and the Amazon basin will usually have a choice between primary forest and secondary forest, whereas in Africa it is increasingly rare for there to be a primary forest available for fields (Okigbo 1982). Since in many swidden societies a field will be planted more than once, the choice will have to fulfill present and projected needs. The site selection depends not only on soil fertility requirements, but also on distance from the house or village, year-round accessibility of the site (whether on a river, over a steep mountain, etc.), potential crops and labour availability, as well as supernatural constraints (sacred groves, presence of spirits, etc.) (Dove 1983; Warner 1981; Brokensha and Riley 1980; Debasi-Scheng 1974; Nietschmann 1973) (see Figure 2).

Soil fertility is recognized by swiddeners as being related to forest growth. A mature forest is usually considered as having soils that are good for the crops (Dove 1983; Warner 1981). This is confirmed by soil research that links nutrients to biomass in the tropical rain forest ecosystem; the greater the biomass, the more nutrients available to the crops (Richards 1952; Jordon 1982; Poulsen 1978). While there is a preference among swiddeners for mature forest, different groups have different preferences as to whether the forest should be primary or mature secondary (Conklin 1957; Nietschmann 1973; Rambo 1983; Beckerman 1987).

Figure 2. Site selection

Many swiddeners simply express a preference for primary forest, and then go on to the next stage of the decision-making for the site. Other groups, however, do distinguish between the soils or topography in their area and classify sites according to these distinctions. In the Philippines the hillside residence of swiddeners makes terrain of prime importance (see Figure 3). The preferred swidden site is on a hillside with a regular slope, for a broken terrain increases the difficulty of clearing, weeding, guarding, etc. (see Conklin 1957).

Figure 3. Southeast Asia: local topographic classification

		Term	Gloss	Local assessment
Tiruray		datar	plain (flat land)	Suitable for swidden sites
		li'ung	plateau	Suitable for swidden sites
		keseligan	hillside(sloping to 75°)	Preferred for swidden
		'uruk	mountain top	Suitable for swidden
		kebah	cliff (sloping 75°-90°)	Too difficult to work, would erode badly
		lefak	creek bed	Not suitable for swidden
		layasan	seasonal swamp	Not suitable for swidden
		luwoluwon	swamp	Not suitable for swidden
	Location:	Southwestern Mindanao, Philippines (Schlegel 1979)		
Hanunóo	duruns~ulan	irregular, rocky	Too rocky for swidden outcrops or boulders	
		ma?agwad	irregular because of valleys and ridges	Not suitable for swidden
		tagudtud	slightly irregular because of ridge-top location	Used for swidden
		ma?ambak	slightly irregular because of a dividing ravine or sharp change of direction	Used for swidden
		danag (or minsan)	regular, all in one plane	Preferred for swidden
	Further qualification:			
		pãtag	level i.e. horizontal	Not desirable for swidden
		banãyad	moderate slope	Preferred for swidden
		madirig	steep	Not desirable for swidden
	Location:	Mindoro, Philippines (Conklin 1957)		
Bontok		chep-ras	rocky terrain	Nothing can be grown
		chao-wang	river, riverside and banks	Not suitable for swidden
		chetar	level portion of a hill or mountain, usually grassland	May be used for pasture
		chal-log	sloping terrain where water runs during the rainy season	May be used for rice terraces
		tengab	steep cliffs	Not suitable for cultivation
		tik-kid	steep land, vertical climb	Not suitable for cultivation
		chumachanak	swampy land	Potential for wet rice
		karayakay	erodible land	Not suitable for cultivation
	Location:	Luzon, Philippines (Prill-Brett 1986)		

Use of soil colour categorization of the soil is common throughout the region. In the Amazon, for example, black or dark soils are regarded as the best, a bit of ethnoagronomic wisdom that laboratory analysis supports (Balée 1989, Johnson 1983). Also of importance is texture; manioc as a root crop requires a soil that is loose in texture so that the tubers can develop (see Figure 4). Among the Machiguenga the forest cover is not perceived as being indicative of good soils since "trees always grow in the forest," regardless of whether or not the soil is good for crops (Johnson 1983). The Kuikuru distinguish between forest on black or red soils, and clear the forest on the black soils for the more nutrient demanding crop of maize. The taste of the soil can also be used, with "sweetness" being an indicator of a better soil (Hill and Moran 1983).

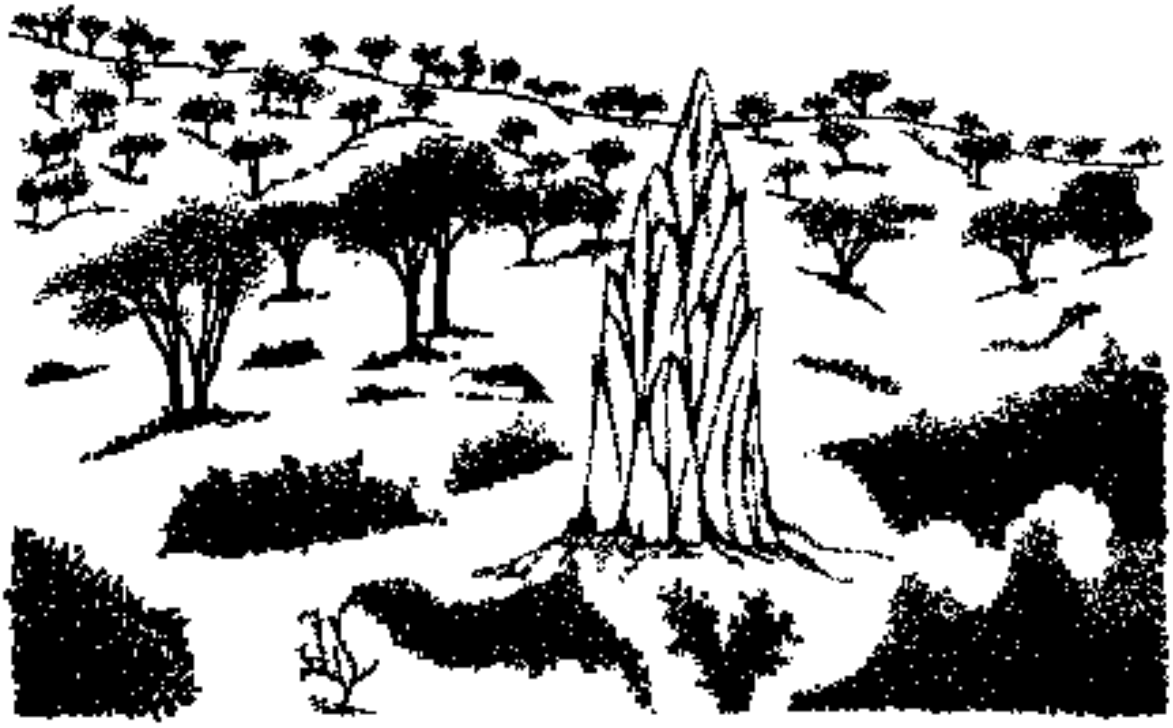
Figure 4. Amazon: local soil classification

		Term	Gloss	Local assessment
Machiguenga	shimentyakpatsa	gravel soil	Best, most preferred	
	potsitapatsari	black soil		Also good soil
	kiraapatsari	red soil		Adequate
	kitepatsari	yellow soil		Not used for gardens
	imvanekipatsa	sandy soil		Easy to work
	Location:	Upper Amazon Staple: Manioc Soil: The best soils are locally described as black, no large rocks, soft (easy to work) and well drained (Johnson 1983).		
Kuikuru		njonjo	red, sandy soil	Used for manioc
		tumbutiiñi	black earth	Preferred, rare, used for maize
	Location:	Central Brazil Staple: Manioc Soil: The best soils are locally described as black earth, and will produce much bigger tubers than red earth. Would prefer to plant their manioc in it, too, but it is rare, so plant maize in the *tumbutiiñi,* since it will not grow well in *njonjo* (Carneiro 1983).		
Wakuenai		--------	black, brownish	Good soils, best in area
		--------	yellow	Better soil, but not available
		--------	white, sandy	Not good for bananas, maniocand sweet potato
	Location:	Rio Negro basin, Venezuela Staple: Manioc Soil: Choose soils on the basis of colour, depth and taste. Taste soils; only sweet or semisweet soils are considered suitable for cultivation (Hill and Moran 1983).		
Ka'apor		iwi-te	well-drained; sandy	"true soil"
	Location:	Brazil, Maranhao State Staple: Manioc Soil: Choose soils that are well drained and sandy. Believe that certain tree species indicate good horticultural soils (Balée and Gély 1989).		
Arawete´		iwi-howi-me'e	blue soil	"makes the corn grow"
	Location:	Brazil, basin of the Xingu Staple: Maize Soil: Choose soil that is dark in color. Area of habitation shows evidence of a long history of intermittent settlement; fertility of the farm sites may result from rubbish pits and managed fallow of previous inhabitants (Balée 1989).		
Yukpa		nóno kurácask	black earth	Preferred soil, best for maize
		sásare	sandy soil	Widespread, not best for maize
		vípopa	thin sandy soil	Only marginal for agriculture
		paráyape	moist clayey	Used for sugar cane
		pirápiraca	hard black soil	Minor use since hard to work
		wayíku	red clay	Only useful for ceramics
		nóno siwiswikano	white earth	Deeply leached, not used
	Location:	Northern Venezuela and Colombia Staple: Maize Soil: Although black soil is recognized as the best, there is not enough to plant for all crops, and maize is given preference. Most fields are of sásare, not regarded as good for maize, although maize will be planted in the first year if the farmer does not have a field of the favoured black soil (Ruddle 1974).		

In the Philippines (Figure 5) a similar attempt at correlating colour of soil and texture to specific crop needs is present. According to these categorization systems, soil is distinguished as to whether a specific crop grows well if planted there. Attempts are made to match specific soils to specific crops for the best combination. These categorizations should not be interpreted as broad "fertility" classifications, they are more concerned with matching crop to soil type.

Figure 5. Southeast Asia: local soil classification

		Term	Gloss	Local assessment
Tiruray		futé' fantad	white soil	Not found in area
		farek	sand	Not suitable for cropping
		tiked	pure clay	Not suitable for cropping
		tamfur	sandy loam	Suitable for cropping, especially suited to bananas
		belatung	dark clay loam	Suitable for cropping
		tintu fantad	light clay loam	Suitable for cropping
	Further qualification:			
		senomor	loose soil	Especially good for root crops although less useful for a general swidden
		batewan	very stony soil	Unsuitable for swidden but is valued for planting creep-eggplant
		filung	rocky soil	Never selected for cultivation
	Location:	Southwestern Mindanao, Philippines (Schlegel 1979)		
Hanunóo		barag?an	gray-to-dark brown clay	Best for root crops, beans, other legumes, and sugar cane; tendency to crack and develop loose topsoil in dry weather so cannot be swiddened as frequently as nãpunãpu? and napu?
		nãpunãpu?	light-coloured sandy clay	Together are considered the best soils for grains and bananas
		napu?	lighter-coloured sandy loam, with higher sand and lower clay content than nãpunãpu?	
		baras	sand	Not suitable for swidden
		bagan-daga?	reddish lateritic soil	Exist in very restricted areas and do not cover sufficient areas to be of major importance
		pará?u	specific types of clay named after the location where found	
		bal~ugu		
		kiraw		
		punsu		
	Further qualification:			
		maganit	excessively hard	Not suitable for swidden
		?ayan?an	firm	Used for swidden sites
		ragunrun	loose	Present on very steep slopes, not suitable for swidden
		mar~ira?	very loose	Not suitable, easily erodes
	Location:	Mindoro, Philippines (Conklin 1957)		



In Africa farmers recognize that crops requiring fertile soil do well if planted on termite mounds.

Termite mounds are often favoured sites for swidden fields. In Africa farmers recognize that crops requiring fertile soil, such as okra and pumpkin, do well if planted on the mounds. Recent studies on the properties of termiteria have shown that the mounds do indeed have higher levels of bases, soil water, organic matter, silt and clay than the adjacent soils (Nyamapfene 1986, Arshad 1982, Mielke 1978). The development of cash crops in Africa as a component of the agroecosystem has been successful because of the knowledge of farmers concerning the relationship of soil colour and vegetation to soil fertility. In Ghana, for example, farmers when choosing a site for cocoa trees prefer the reddish brown upland soil rather than grey sandy soil, and look for the presence of certain trees on the potential site. Occurrence of trees such as Cylicodiscus gabunensis and Ricino dendron hendolotii is perceived as indicating soils good for cocoa, "while poor cocoa soils are associated with Mallotus opposilifolius and Aracia pennata (Bennah 1972: 252).

While it is recognized that fields from primary forest require less weeding and may give higher yields, primary forest requires more work in cutting and takes longer to dry for burning (see Dove 1983; Freeman 1970). The future uses of the proposed site are also considered; if, as with the Iban and Tagbanwa, the fields will be cropped for a second year, then the extra labour investment in clearing mature forest may be considered worthwhile (Dove 1983; Warner 1981).

To find a site with primary forest (and, if it is considered, with a particular soil or terrain) is just one step in the decision-making process in site selection. Specific location of a site requires judgements that take into consideration the utilization of other resources of the agroecosystem as well as residence customs and labour availability. Since travelling is by foot (or in some regions by boat), the field cannot be so far from the household residence that too much time is spent going and coming. "Too much time" spent travelling to the field and back is culturally defined, and depends on the perceived opportunity costs of pursuing agricultural rather

than other activities (Vickers 1983). If other activities (hunting, fishing, gathering) will be carried out, the field site must not be so far away that it will curtail them. Since agriculture is only one component of the agroecosystem, the time spent on swidden activities must be limited, agricultural activities cannot absorb the time that other economic activities require.

Residence moves by individuals or by a village or hamlet occur when some components of the agroecosytem demand time and energy that should be spent on others. The multi-economic niche strategy requires that the various components be in harmony with one another so that the agroecosytem can retain its stability. If fields are too far to allow hunting or fishing, or when, because of game depletion, hunting requires expending time that should be devoted to agriculture, a change of residence or field site occurs. In Africa, where swidden is usually supplementary to permanent fields and, in many areas, cash tree crops, the site is tied to a fairly close radius around the village or homestead. The farmer must find the best swidden site within the area, but in areas of land shortage the head of the extended family may be the final arbiter, since the individual farmer will have to obtain his permission before final site selection (Engle et al 1984).

The specific resources of a potential site in the forest are also considered. The Chacibo of Amazonian Bolivia favour sites near the vicinity of Brazil nut trees so the women can collect the nuts when tending to the fields (Boom 1989). At the time of site selection, thought must also be given to the harvest, for a distant site will mean hours of drudgery carrying heavy loads of the harvested crops back to the homesite. To ease the burden of travelling between home and field, field houses may be built in which family members will stay off-and-on for the season while maintaining a house in the village (Salick and Lundberg 1989). Among some groups, families will build watch houses in which to stay during the day to scare animals and birds, but the family members will return to their home every evening (Warner 1981).

All of these variables of soil, distance, crops, other economic activities, etc., require that the swiddener have not only the environmental knowledge to judge the agricultural quality of the field site for agriculture but also the managerial ability to judge whether its location will allow other important economic activities to be maintained.

Once a potential site is found that satisfies soil and distance requirements, supernatural factors may also have to be considered. In some societies rituals are performed to test whether the field is a good one, e.g., free of bad spirits. If the portents are bad, it will be abandoned as a potential field site and another chosen (Warner 1981). If the supernatural gives approval, the swiddener then has to consider his array of potential crops/varieties and their suitability for the proposed field. Are the slopes a bit too steep for rice? too wet for maize? Will a favoured rice variety do well in poorly drained soils? If the site meets these criteria, the clearing will begin.

Then comes the labour consideration of how big to make the field (see Figure 6). Although communal task groups may occur, the main swidden work group for most tasks is the independent household family (Weinstock 1986). Usually, if more labour is needed than the household can supply, exchange labour arrangements will be made. The resulting labour force may be communal in appearance, but individuals within the group will be accruing or repaying labour obligations. Amazonian societies that are engaged in sporadic warfare, such as the Yanoama, may engage in group clearing of primary or mature forest and then divide and manage the field individually (Smole 1989).

It is universal in swidden societies for men to clear the high forest, yet the size of the finished field is determined by more than a man's ability to clear. Factors such as how much time a man can spend clearing without sacrificing other economic activities, and how large an area the family labour will be able to keep weeded and protected also have to be considered (Debasi-Schweng 1974, Engel et al 1984). The ambitions of a family will also play a part. To make a large field is a necessity in many societies when a family wants to acquire status, since generosity with food, entertaining with feasts, etc., are prerequisites for prestige. Although there is no limitation on how small an area a family can farm, there is a limit on how large a field a family can manage. Few swiddeners attempt fields larger than two to three hectares, although there might be swidden fallows of the same or greater size that are visited, occasionally weeded, and sporadically harvested.

Figure 6. Size of field

The decision of how large a field to clear usually hinges on another decision as well -- *when* to clear the field. There is a relationship between the pattern of rainfall and the attention given to the scheduling of clearing. The heavens and earth are scanned for signs that the time has come (see Figure 7). In areas of more or less constant rainfall, fields are cleared throughout the year. Swiddeners in these ever-wet regions clear fields as needed, usually when there is slack time in their pursuit of other resource activities. Where there is more variation in rainfall or a marked dry season, there is an attempt to utilize the dry period to get a "good burn." These periods of no rain may be quite sporadic and of short duration, a few days here and there of dry amidst periods of greater or lesser rain. The goal in such areas is to be able to "catch" these dry days (see Figure 8).

A much better burn is possible where there is a dry season than in the constantly humid areas. In areas of a marked dry season of two to three months, swiddeners cut the forest during the waning days of the rain and leave it to dry. Swiddeners attempt to time the clearing to optimize the potential burn: if the trees are cut too soon and heavy rains continue, the vegetation will rot rather than dry and not burn well, but if the field is cut too late, it might not dry in time for burning and planting (Carneiro 1983, Johnson 1983).

Figure 7. Southeast Asia: indicators of when to start clearing the swidden field

		Indicator
Tiruray		*Primary indicator:* Presence of the constellation Seretar at approximately 20 degrees above the horizon at starbreak. *Secondary indicators*: The beginning of the *megenihan* wind from the east, and the flowering of certain wild plants.
	Location:	Southwestern Mindanao, Philippines (Schlegel 1979)
Eastern Taubuid		The flowering of the saring vine (Maesa gaudichaudii A. DC.) signals the start of the swidden cycle, the clearing of forest land.
	Location:	Mindoro, Philippines (Pennoyer 1981)
Iban		When Bintang Banyak (Pleiades) first appears above the horizon at dawn, this is the time for the commencement of the manggol rites (i.e., the taking of omens and the first clearing of the undergrowth at the ritual centre of the farm).
	Location:	Sarawak (Freeman 1970)
Semai		It is time to begin clearing fields when a certain kind of tree called perah (Elateriospermum tapos) puts out new leaves.
	Location:	Malaysia (Dentan 1968)

Methods of clearing are consistent throughout the tropics. There are two stages: underbrush is first cleared followed by the trees. The clearing of large trees requires time and skill. Since pioneer swiddeners initially moving into forested areas often have little experience with felling large buttressed trees, they often hire integral swiddeners to clear the trees. Among integral swiddeners, themselves, felling trees is regarded as a dangerous task that requires experience, so young men may ask, or even hire, more able men to cut the larger trees (Warner 1981).

The well documented central African *chitemene* swidden system is based on a farmer cutting or lopping trees from an extensive area, carrying the cuttings to a central area, which when burned will become the swidden field site (Fosbrooke 1974, Schlippe 1956, Richards 1939, Peters 1950, Trapnell 1953, Manshard 1974). These fields are usually circular and may include a termite mound (Schultz 1976, Schlippe 1956, Mielke 1978). Although labour intensive, the chitemene system is unique in utilizing the nutrients stored in the biomass of a large area (the "out-field" where trees are cut/lopped may be 8, 12 or even 20 times greater than the "in-field" area burned and cultivated) to enrich, once burned, a relatively small field site (Ruddle and Manshard 1981, Chidumayo 1987, see also Haug 1983, Vedeld 1983).

Selective cutting is a common management technique for maintaining forest succession. Species that are valued are spared during clearing, although some may be coppiced or cut at waist height (Fosbrooke 1974, Denevan et al 1984). Trees good for timber, nuts, oil, and fruit are routinely protected if either on the forest edge or within the field itself. These trees may be protected throughout the period of cultivation, and when the field is left to fallow they will form the basis for the first stage of forest succession (Denevan et al 1984, Engle et al 1984, Yandji 1982).

In summary, the decisions of where and what size to make a field, and how and when to clear it, require a swiddener to have an intimate knowledge of the physical environment, labour availability for the swidden component of the agroecosystem, crop requirements, and the future agricultural, raw material, etc., needs of the family. These decisions are linked to similar decisions made in the past and decisions that will be made in the future. The goal of having previous fields in various stages of succession depends on consistently making the right decision concerning the right place for the field site.

Figure 8. Desanâ agricultural calendar

The Desanâ of the Upper Rio Negro in western Brazil live in a humid area (rainfall throughout the year). They use constellations to determine the schedule of the very brief dry periods. The constellations are used to create an economic calender in which agricultural, gathering and fishing activities are scheduled. It is difficult to ascertain whether the local technical knowledge of the constellations empirically "works." What is more important is that, in an uncertain environment, by correlating the atmospheric and celestial changes, fruit ripening, etc., a conceptual framework for bioclimatic observations has been created that attempts to locate those elusive, but vital, periods of no rain (Ribeiro and Kenhíri 1989).

Constellation*	**Weather**	**Clearing and burning activities**
OCTOBER		
Pit Viper[1]	Heavy rains	Clear underbrush; cut down trees
NOVEMBER		
Pit Viper, round, tail	Heavy rains	
DECEMBER		
Pit Viper, round, tail	Heavy rains (floods)	
JANUARY		
No constellation	Dry season - 5 days long	
	another dry season:	During the end of *inga* dry season
	inga [2] summer occurs toward the end of the month : 8 - 15 days	fields cleared in October are burned (believe they need at least 7 days of hot sun to ensure a sufficient burn)
Armadillo, femur	Rains not heavy enough for flooding to occur	
FEBRUARY		
Armadillo	Rains	
MARCH	*cucura* [3] dry season - 4 days long	
	light rains	
	followed by two weeks of dry season: *peach palm* summer	Trees cut down in November and December and the underbrush cleared in January are burned.
APRIL		
Shrimp	Not always rain; when this occurs, *peach palm* summer continues until mid-April	
Jaguar, chin	Heavy rains; flooding	
	2 or 3 sunny days interspersed with rain	

continued on next page

Jaguar, body	Heavy, intermittent rains	
	4 -5 day dry season: *Umari* fruit dry season	
Jaguar, tail, round	Heavy rains	
MAY - mid JUNE		
Star, piece	Intense, constant flood rains	Remove underbrush
Fish, smoked	Intense, constant flood rains	
Gourd with *umari* pulp on a stand	Intense, constant flood rains	
JUNE		
	Three day dry spell	Burn underbrush cut in May; plant maize
Adze feathered ornament	Rains	
JULY		
Otter	Rains	
Birds, very pretty	Rains	
Crab, very pretty	Rains	
AUGUST		
Star, piece	Rains (rivers high)	Clear forest for new fields; clear undergrowth in old fields
SEPTEMBER		
	2 - 3 dry days: larva, old summer	Burn the underbrush cut down in August
	Rains	
	5 day dry spell: larva, pretty, summer	Underbrush burned in old fields
Crane, flood	Rains	
	5 day dry spell: thorn, summer	If underbrush not burned by this time, it is impossible to clear the fields, because weeds start growing and there are not enough consecutive sunny days to complete the burning.

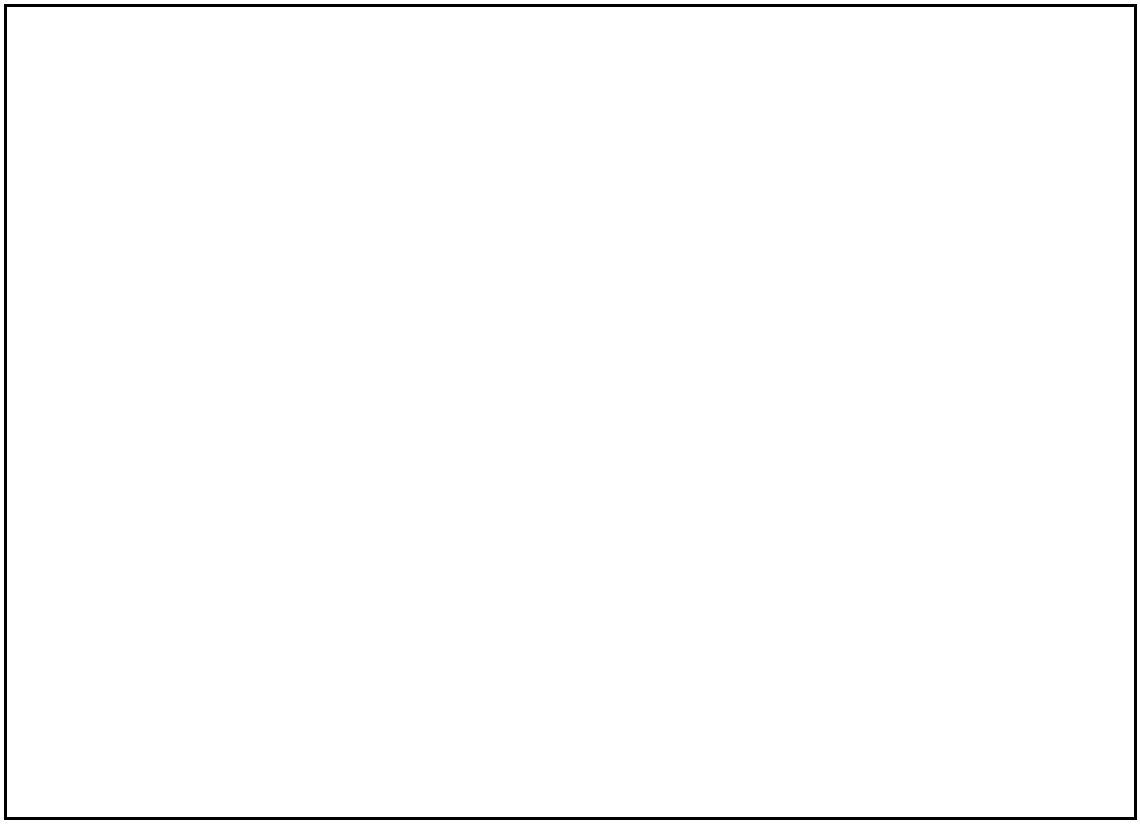
Note: *The names of the constellations are the same names given to the rains that occur during the time they are visible, e.g., the rains that occur during "pit viper tail" are "pit viper tail rains".

[1] Transforms from Pit Viper Illumination to Head, then Body, then Eggs of the pit viper.

[2] Inga is a fruit that is gathered during this time and eaten (Inga spp., Leguminosae).

[3] Cucura is a fruit that is gathered during this time and eaten (Pourouma cecropiifolia, Cecropiaceae).

Source: Ribeiro and Kenhíri 1989



Burning of a field in preparation for planting

Burning

Burning is essential for a good crop with a minimum of labour. There are six beneficial effects of burning (Rambo 1981: 5 - 9):

1) *Clearance of unwanted vegetation from the field;*
2) *Alteration of soil structure, making planting easier;*
   The heat of the fire changes the texture of the earth and makes it more friable. Walking on a burned field is like walking on tiny ball bearings that roll underfoot. This loose texture is easy to plant with a dibble stick and provides a good seed-bed (see also Conklin 1957; Tivy 1987).
3) *Enhancement of soil fertility by ashes;*
   When the vegetation is burned, large quantities of nutrient rich ashes are deposited on the soil surface providing the newly planted crops with the benefits of the biomass that has grown on the site (Sanchez 1976: 363 - 365; see also Dove 1983; Tivy 1987).
4) *Decrease in soil acidity;*
   Since plant ashes are generally alkaline, with burning there is an increase in soil pH. This helps with one of the more serious problems of tropical soils, aluminum toxicity, since an increase in soil pH reduces the exchangeable aluminum (Moran 1981: 116 - 117, Popenoe 1960: 100).
5) *Increase in availability of soil nutrients;*
   The heating of the soil makes the stock of stored nutrients available to plants (Nye and Greenland 1960: 71 - 72).
6) *Sterilization of soil and reduction of the microbial, insect and weed populations.*
   The heating of the soil controls weeds and reduces insect, nematodes, and various pathogen populations (Glass and Thurston 1978: 110). The elimination of weed seeds means less weeding, which is why swiddeners associate high forest and good "hot" burns with little weeding and high yields.

It is recognized by swiddeners that a good burn improves the yields of the fields and reduces the time spent in weeding. The problem is how to get a good burn? Whereas site selection and clearing are activities over which the swiddener has control, the results of burning depend to a large degree also on luck. A swiddener can do an exemplary job of site selection and clearing, only to obtain low yields because the rains came too soon for the field to burn well. The decision as to when to burn is usually one that is made by the individual, although, for

example, among some of the hill tribes of Thailand the decision is made by the elders and the entire village burns its fields on the same day (Keen n.d., Kunstadter 1987).

Choosing the time to burn is difficult since for a "good burn" it must be done after the wood is dry, but before the onset of the rains. In the perhumid zone around the equator the dry season may be so short as to be effectively non-existent, and burning is difficult (Harris 1973: 252). Rather than praying to the gods or spirits for rain, in the equatorial region the prayers are for the rains to stop so that the vegetation will burn (Vickers and Plowman 1984). Since it is such an important decision, which will have ramifications throughout the rest of the swidden cycle in both labour and productivity, the decision of when to burn is fraught with anxiety.

In many swidden societies this anxiety is allayed by rituals or, perhaps more effectively, by reliance on environmental indicators (leaves sprouting, sighting of birds, etc.) that "tell" that it is the proper time to burn (see Figure 9) (Richards 1985). With or without rituals, anxiety exists.

Ideally a field will be burned just prior to the coming (or increasing) of the rains. If it is burned too soon after clearing, the vegetation will not be dry enough and weeds might start establishing themselves in the burnt field. This would mean the field would have to be weeded prior to planting (Warner 1981: 20). A poor burn will require a secondary burn. Vegetation that has been partially burned will be put in piles, sometimes mounded around unburnt logs, and then burned again. In some of the wetter areas this will have to be done repeatedly until the field is judged to be adequately burned. In a community there are always individuals (it is more a matter of how many than how few) who have fields that have not burned well, and it would be a rare swiddener who sometime during his lifetime did not experience a poor burn (see Box 1).

If the society is one in which a family may have several fields, for example, when one field is cut from primary forest and another from the previous year's field, then one field may be burned earlier than the other so as to increase the odds of having at least one field mesh with the rains (Warner 1981). Again, it is an attempt to minimize risk through a strategy of diversity and variation.

Box 1. Burning anxiety and adaptation: Tagbanwa of Palawan

The Tagbanwa are an integral swidden people who, in response to their perception of the hinterland soil as unsuitable for agriculture, traditionally inhabited areas along both the east and west coasts in the central portion of the Philippine island of Palawan. The natural environment is one of the small steep valleys running west to east from the mountains and foothills in the center of Palawan to the beaches of the South China Sea. The coastline is shallow with reefs extending from the shore into the sea. Because of the terrain, the rivers are short and steep in gradient.

The west coast is climatically characterized by two distinct seasons, wet and dry of about equal duration. Ideally, the dry season begins in October and continues until April. After a transition period of variable winds and calm the summer monsoon rains begin in June and continue into October. The rainfall does not usually reflect this idealized season pattern. Although the winter months (November-December) are supposed to be dry, rains may fall through January, while the rainy season can start in either April or May, pause in July or August, and then resume in September and continue until February.

Not only is there variability from one year to the next, but from one place to another along the coast, for although the west coast is classified as forming one climatic area, within these broad boundaries there are many variations.

Choosing the time to burn is recognized as crucial -- the goal is to have a dry field burned just before the rains begin. Since fields are usually not contiguous, burning is an individual decision. There is a strong psychological element in the decision to burn. When fields are burned the smoke is highly visible against the sky. Everyone knows who is burning and where, and the tension grows as individuals visit their slashed fields and watch the sky. The rains come from the east with huge cloud banks forming over the sea and darkening the horizon. When these cloud banks begin to occur, fields that have not been burned will be, their smoke adding to the already dark sky. Nevertheless, some individuals may linger too long and get "caught" by the rains. They will face secondary burning and more hours in tedious weeding.

Source: Warner 1981

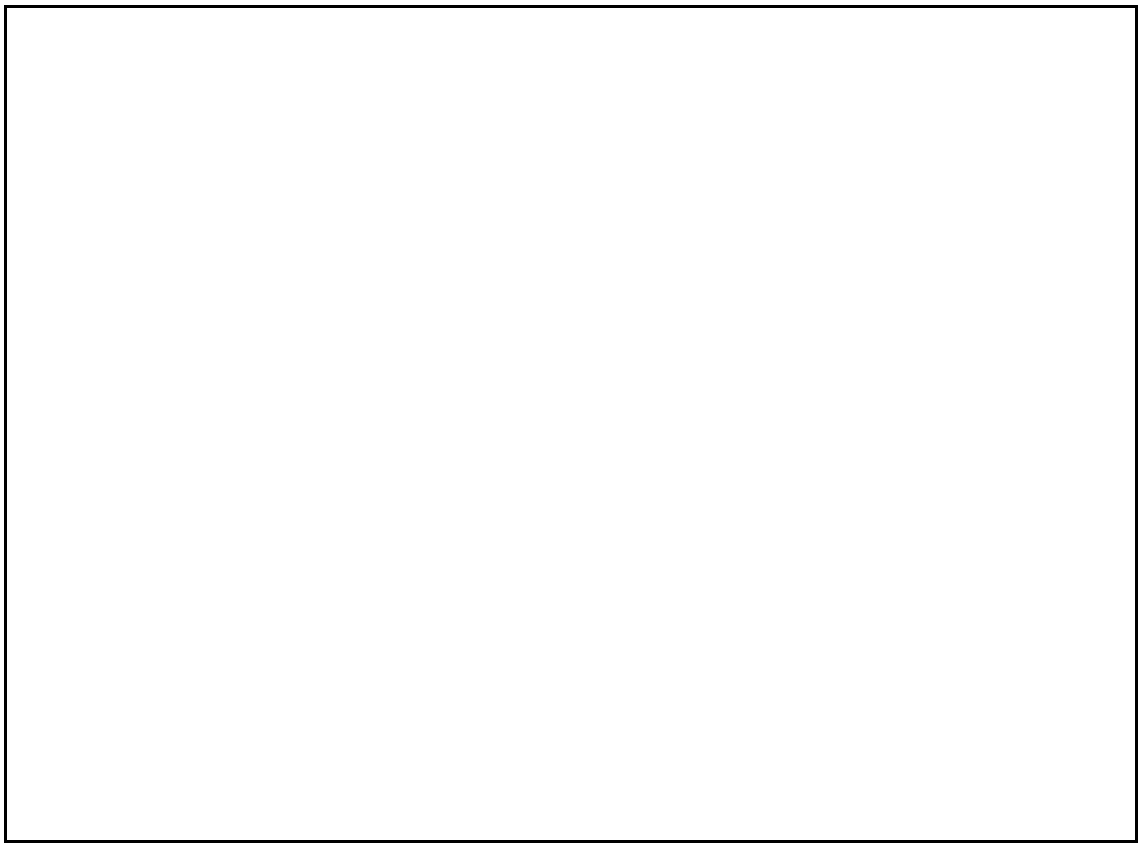
Figure 9. Local indicators of the coming of the rains and the optimal time to burn

		When	Indications
AMAZON:			
Machiguenga	Rule of thumb: 5 consecutive days of strong, hot sun make for a good burn. No rituals.		so when others burn their fields, there is pressure to burn as well.
	Location:	Upper Amazon. Since it rains every month gardens are never really dry, and never burn cleanly. Although most gardens are burned in September or October after being cleared in April or May, gardens are burned throughout the year (Johnson 1983).	
Kuikuru		After 2 or 3 months of dry season; ideal time is a month before the rains begin so the manioc can be planted to take full advantage of the rains.	When the turtles lay their eggs on the beach and the constellation *ofonjo*, the duck, is seen in the eastern sky before sunrise, it is time to plant, for the rains will soon begin.
	Location:	Central Brazil. A definite dry season with no rain falling for two or three months (Carneiro 1983).	
Yanoama		A few sunny, windy days are the best that can be hoped for.	No rituals. No clearly defined time of the year when gardens can be cleared and burned most easily. "Rainy weather is so common that out of desperation people sometimes attempt to burn...after only a day or two of sunny, windy weather."
	Location:	Parima highlands of Venezuela and Peru. No real dry season (Smole 1989:117).	
Siona-Secoya	No month drier than 60 mm.Shaman may appeal to the spirits for of rainfall, more attempts to burn during the driest 3 months.		a cessation of the rains so the fields may be burned.
	Location:	Northeastern Ecuador. No real dry season (Vickers and Plowman 1984:19).	
Yukpa		Dry season (December- March).	Early rains signalled by the *tiprína* (chichara: Cicadidae spp.) singing. Know when the main rains arrive because the savanna grasses flower. The dry season is signalled by the *tátrimo* tree whose leaves turn brown and fall. Since inhabitants believe that the smoke of the burning field causes rain, burning is a communal activity. Rituals performed before burning.
	Location:	Northern Venezuela and Colombia. Marked dry season followed by lesser than the major rains. Staple is maize rather than manioc (Ruddle 1974).	
SOUTHEAST ASIA:			
Tiruray		After 3 - 4 weeks of drying.	Stars tell the general season for burning: anytime from the culmination of the Tiruray constellation Kufukufu until that of Seretar. Day of the burn should be either a Monday or Saturday as these days are believed to belong to the spirit of fire. Wind blowing.
	Location:	Southwestern Mindanao, Philippines (Schlegel 1979).	
Lua'		Fields are burned a few weeks before rains.	Lua' avoid burning during a time of waning moon for fear there will be too many weeds. Adjacent villages coordinate burning, so approximate date is known months in advance.
	Location:	Northern Thailand (Zinke, Sabhasri and Kunstadter 1978).	

In most swidden societies burning is a male task. If the field is on a hillside surrounded by forest, a common burning technique is to start at the bottom of the hill and work upwards. Using a torch, fires are started throughout the field and special care is given to large felled trees. If a field shares a border with a cultivated field the fire is commonly started on the shared border and directed toward the slashed field.

Escape fires can occur. There is a nonchalance regarding escape fires and the potential destruction of forest in most of the perhumid tropics. This can partly be explained by the wet conditions of the forest in this zone -- a fire will usually not escape far and little damage will occur. In the Amazon, for example, the forested areas are so large that the areas burned by escape fires are only a small part of the total forest. The accidentally burned forest is perceived as being able to recover rapidly, especially in the perhumid areas. In the drier areas, however, the fires will escape further and substantial damage can occur, with large trees being burned and falling. This may still not be regarded as a problem. Since the hunting in these areas will be good, the burnt forest becomes an enriched resource. Gardens may even be planted in the areas burned by the escape fires and regarded as a low labour windfall with potential yields (Ruddle 1974).

Within the fields, the vegetation that was selected and spared during the cutting will be protected from the fires. The area around a favoured tree, for example, may be cleared so that the fire will not come close enough to permanently harm it. The protected vegetation will remain in the field throughout the cropping period and will become part of the natural succession to forest.



Planting the swidden

Planting

Once the swidden is burned, the decision must now be made as to when and what to plant. The decision to start planting is a crucial one. After burning there is a layer of nutrients on the fields that will be rapidly washed away by rain. In perhumid areas the swiddener will quickly plant a burned field. In areas with a dry season, there is a need to get the field planted quickly once the rains begin so that the plants can utilize the nutrients before they are lost to the system. In Africa it was estimated that a week's delay in planting could result in a 1/3 reduction in yields (Porter 1970). The decline is a result of the leaching of nutrients by the rains, and to a lesser degree the

water shortages that occur as the season continues. The seeds planted when the ground is dry will "put out extensive root systems, taking advantage of the ephemeral presence of the large quantities of phosphorus and other minerals. Late planted crops developing in moist or saturated soil build less extensive root systems and are more vulnerable to drought, should it occur later in the season" (Porter 1970: 193).

The decision to plant is still further complicated by the uncertainty as to whether the rains have indeed started, or whether it is simply a short period of rain that will be followed by another period of drought. How to tell that the rains have started? It is common for swiddeners in regions that have a dry season to have environmental "cues" that foretell the coming of the rains. The climatic shifts reflected in winds, cloud movements, and color of the sky (red at sunset or sunrise, blackness in the afternoon, etc.) are studied and discussed (see Figure 10).

In West Africa climatic cues are supplemented by what Richards (1985: 47) refers to as "leaf indicators" (the leafing of specific plants), as well as the songs of certain birds. Throughout Africa and Southeast Asia when termites swarm it is interpreted as a sign that the "true" rains have begun, rather than the "false" rains that are followed by the return of the dry season. Do these "cues" accurately foretell? Further study is needed on these cues to determine their accuracy, especially the objective rather than interpretive ones, such as leafing (Richards 1985). In any case, by watching for these cues the swiddener becomes sensitive to his environment, which probably gives as good a basis for the decision as is available to him, as well as relieving some of the anxiety surrounding his decision.

Since swiddeners have such a variety of crops, they can stagger the plantings in relation to the conditions under which the specific crop will do best. Crops, or specific varieties of crops, that can do well in relatively dry conditions are planted first, to be followed by crops or varieties that demand moist conditions. As with burning, if there is more than one field, there is a tendency to diversify even further, so that one field may be planted earlier than another, perhaps with different crops, in the hope that at least some of the crops in one of the fields will be planted under what turns out to have been optimum conditions.

Unlike the Western farmer who sits on the tractor and "works large and regular areas . . . and must, to some extent, take the bad with the good", the swidden farmer is down on the ground, can examine at first hand every inch of the field, and can be selective, matching crops to soil, drainage, shade, etc. (Allan 1965: 87). It would probably be more accurate to state that what is perceived by the swiddener is not one field, but many microsites, each with its own characteristics. These characteristics are noted and used when planting is done (Wilken 1973; Denevan et al 1984; Conklin 1957; Warner 1981, Salick and Lundberg 1989). When a swidden field is planted the visual result, as viewed by the outsider, is a mixture of plants that defies his idea of order. But to the swiddener, the field is a reflection of the soil variation in the fields and the plants that will do best in each microsite.

Figure 10. Southeast Asia: local indicators of the time to plant

	Crop	Indicators
Tiruray	Rice	Position of key constellations for the general period. Precise day for planting is reckoned from the moon, which indicates auspicious and inauspicious days.
Location:	Southwestern Mindanao, Philippines (Schlegel 1979).	
Iban	Rice	When the Bintang Banyak (Pleiades) appear at the zenith shortly before dawn, this is the season for dibbling to begin and the first sowing of rice.
Location:	Sarawak (Freeman 1970).	

When a field site is chosen, trees and plants already growing there may be protected because of their edibility, medicinal uses, fiber content, or other economic values. In addition to these advantages, there is also the benefit of leaving bits of the existing vegetation in the field as providers of shade, mulch, wind protection, climbing poles for vines, etc. This form of microsite management alters crop climates by forming larger areas of desirable characteristics (usually protection from heat and sun) and preserving these characteristics within the crop zone (Padoch and de Jong 1987; Wilken 1973: 545).

This intensive microsite management would be impossible in huge fields. It is the size of the swidden that enables it to occur. The small swidden field that appears so chaotic is the end result of the application of the best traditional knowledge concerning old crops, new crops, preserved vegetation, soils, and microclimate manipulation. (Stigter 1984: 174).

This diversity is further elaborated by the practice of interplanting and by the active creation or maintenance of microclimates within the microsites. After a long history of being discounted as a chaotic, inefficient jumble, interplanting (also referred to as intercropping) is now recognized as a highly efficient strategy in the tropics. Not only does it allow the matching of crop to microsite, but by the dispersal of the crops throughout a field it discourages insect pests and diseases. The swiddener's staggered planting of a sequence of crops rapidly creates and maintains a soil cover that protects the fragile tropical soil from leaching and erosion (Rappaport 1971; Harris 1976).

Box 2. Amazonian planting patterns

There has been a lively discussion in the literature about the cropping patterns used in the Amazon. It was widely accepted that swidden fields in the humid tropics were analogous to the forest -- many varieties interplanted throughout the field. Research revealed a different field pattern (with variations) in the Amazon. Crops were found to be planted in monocrop rings or clusters, rather than interplanted with other crops throughout the field.

Part of the explanation lies in the interpretation of what a monocrop is -- one crop or one *variety* of that crop. Manioc, for example, may be the only crop planted within a zone of the swidden, but the zone may contain many *varieties* of manioc. Field sites can vary widely through the years in soil quality and drainage. In a response to these variations, genetic diversity in manioc is actively maintained so that there will be the right manioc variety available for the right microsite (Hames 1983: 22 - 24). A "pure stand of...manioc can itself be considered a polycrop of distinct cultivars with differing branching pattern, leaf shapes, and growth periods" (Boster 1983).

Which crops are planted in which zones depends upon the specific crop needs, vulnerability to pests, and the field microsites. It is in connection with these microsites that an observer is aware of "patches" of the same variety within the field. The Ka'apor, for example, plant the fast growing manioc varieties, which are subject to destruction by leaf cutter ants, in the center of their swidden fields and the slow maturing varieties, which are immune to attack, along the periphery. It is a technique designed to create as much distance as possible between the ants and their preferred host plants (Balée and Gély 1989, see also Stocks 1983).

To plant crops in rings might be a response to environmental conditions in the Amazon that might not occur in other regions. The concentric rings use an unusual field architecture where "a ring of bananas/plantains surround a ring of manioc which surround a circle or ring of short plants such as peanuts, sweet potatoes, or mixed small crops." This cropping pattern is found in widely separated areas of the Amazon (Beckerman 1984, Flowers et al 1982, Stocks 1983). The banana/plantain rings may protect the manioc from the major mammalian pests: agoutis (Dasyprocta punctata), lapas (Cuniculus paca), and peccaries (Tayassu pecari and Pecari tajacu). Since banana and plantains are post-contact plants, before their introduction a ring of bare ground might have been cleared around the manioc to protect the crop since the mammalian pests do not like to cross bare ground. Since banana and plantains leaf high, the animals perceive the ground as bare, even though plants are present. If animal pests were such a problem in these areas, the development of cropping patterns of clumping and rings would help in field protection, whereas trees dispersed throughout the field would encourage predation (Beckerman 1984).

Another explanation of the concentric rings in the Amazon is provided by their role in soil management and improvement. Among the Kayapó the center ring is in polyvariety sweet potatoes. This center ring is burned frequently in a practice known as "in-field burning," which increases the level of potassium in the soil. By segregating the sweet potato, management practices, such as frequent burning, can be used without harming other plants. Mulching of the sweet potatoes with banana leaves, etc., taken from the outer ring to the inner is also practiced (Hecht and Posey 1989).

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The Bora's clustering of plants in zones with fruit trees either in the middle of the field or on the high ground is a reverse of the "funnel" rings of the Kayapó and Ka'apor where the taller plants were on the periphery and the short plants in the center of the field. The Bora cropping pattern of clustering the trees facilitates weeding, harvesting and maintenance of the orchard, while the peripheral areas enter fallow and become regenerated forest. Regeneration of the forest in the swidden is not hampered by the orchard, yet the productivity of the field can be extended (Denevan et al 1984). The Amazonian swidden field is generally kept in prduction longer than its counterpart in Southeast Asia and Africa. The heavier reliance on root crops and plantains is the basis of this difference. Manioc and sweet potatoes are kept in production through relay planting (during harvest there is replanting) for two, or occasionally three, harvests. Plantain clumps can continue for four or more years. By clustering the crops, production is maintained in some areas of the field, while other areas, the periphery in the cases above, become part of the forest succession. It is a cropping pattern that is multipurpose and well suited to the poor soils, pests, and the crops of the region.

	Cropping pattern	**Crops**
Barí	Concentric ring	Taller plants on the outside and the lower ones innermost
Bora	Zonal, clusters	Fruit trees in center and/or high ground
Candoshi	Concentric ring	Taller plants on the outside and the lower ones innermost
Ka'apor	Zonal, angular	Fast growing manioc in center
Kuikuru	Zonal, clusters	Plant same variety manioc in same area
Kayapó	Concentric ring	Central zone dominated by sweet potatoes; secondary ring begins in maize and ends up in manioc/sweet potato polycrop; external ring includes yams, bananas, pineapples, *urucu*, and fruit trees.
Mekronoti	Concentric ring	Taller plants on the outside and the lower ones innermost
Mundurukú	Concentric ring	Taller plants on the outside and the lower ones innermost
Yamoama	Large zones, match plant to soil and shade	Large areas of the staple plaintains intercropped with annuals to create diverse forest-like zones
Yukpa	Zones with some interplanting	Main part of the field planted with maize; smaller areas, sometimes in segregated blocks, traditionally interplanted beans with maize. Field sequence: maize->manioc->plaintain.

Sources: Beckerman 1983b, 1987, Denevan and Tracy 1988, Stocks 1983b, Flowers et al 1982, Carneiro 1983, Balée and Gély 1989, Smole 1989, Ruddle 1974.

A highly diverse interplanted multi-storied field similar to the natural forest structure is found in the Amazon and Southeast Asia and to a lesser extent in African swiddens. Fields are planted with a diversity of crops and polyvarieties of staples distributed throughout the field (Moran 1981). More common in the Amazon is a pattern of "clumps" or zones of monocultures, sometimes arranged in rings, rather than interplanted throughout the field (see Box 2) (Beckerman 1983, Beckerman 1984, Hames 1983, Boster 1983). What both interplanting and zonal cropping patterns share is an attempt to establish quick ground cover, maintenance of trees and plants that existed at the site before clearing, and utilization of polyvarieties of staples.

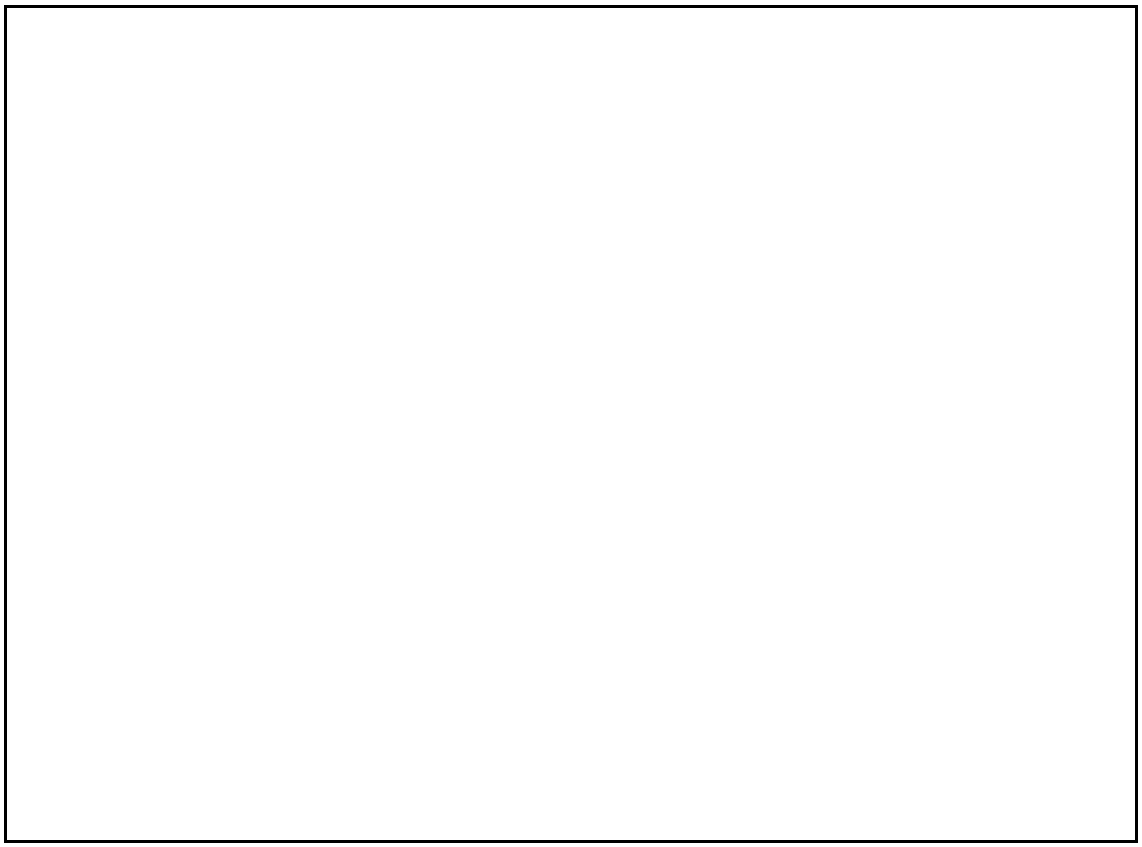
By interplanting a variety of plants the labour of planting and harvesting is spread over a longer period of time than it would be if only one crop were planted. Reliance on family labour is a serious constraint if an agroecosystem has sharp peaks of labour requirements. This is sometimes overlooked in discussions of the labour needs of multi-cropping vs. monocropping. Monocropping may require less labour overall (depending on

the crop), but if the labour demand is concentrated within a short time period, a swidden family may not be able to provide it (see Beckerman 1983).

This problem recurs during harvest time. To have only one crop, or the bulk of a field in one variety of a crop, that demands prompt harvesting or processing (a single rice variety being a good example) might require labour beyond what the family can provide. Crops may go unharvested in the field or rot in the storehouses if the labour for harvesting and processing is not available when needed.

Staggered planting and multicropping establishes a sequence of crops that can be harvested and processed in turn. The labour peaks that may occur are "smoothed" so that the family can provide the necessary labour (Debasi-Schweng 1974: 80). Since the decisions as to when to cut, burn and plant are usually made by the individual households, within a community each household may be in slightly different phases in their swidden cycle in relation to the others. This enables a small pool of extrafamilial labour to form within the community, which may be available for a day here or there as needed. As can be seen, what is crucial is not just the amount of labour that is required, but the timing of the labour. Swiddeners try to eliminate labour peaks and troughs and attempt instead to establish through diversity and variation an even flow of energy through the agricultural cycle.

In summary, when to begin planting, what to plant, and the sequence of planting are all decisions that have to be made by the swiddener. Again, as with burning, the decision as to when to plant is fraught with anxiety; too early or too late a planting will require more labour for weeding and lead to potentially low yields. Swiddeners, however, have adapted to this by utilizing staggered plantings of diversified crops.



Weeding a swidden planted in a circular cropping pattern

Weeding and protecting

Weeding has long been recognized as one of the important determinants of agricultural yields in the tropics (Chang 1968; Janzen 1973). The same post-burn nutrient conditions that are so beneficial for planted crops, are also extremely beneficial for wild plants (Uhl 1983). It has been estimated that effective weeding can increase yields in the tropics and sub-tropics as much as 100 percent or even more (Ashby and Pfieffer 1956). Therefore weeding is an essential task, which must be done or there will be a sharp decline in yields, or even the loss of

the entire crop. A good burn eliminates the weed seeds, so again, the right timing of the burn has repercussions throughout the rest of the agricultural cycle. The amount of biomass burned also has an effect; since a good burn is defined as a "hot" one, a mature forest that is cut, dried, and well burnt, means fewer weeds at least for the first 6 - 9 months (Hames 1973: 24).

Many researchers cite weed infestation as the basis for the decision to stop investing labour in a swidden site, rather than a drop in soil fertility. Although the nutrient benefits from the burn start to drop quickly to the initial pre-burn level (Nye and Greenland 1964; Andriesse 1977), the drop and continued nutrient decline is not considered to be as important in the decision to clear another field as the increase in labour requirements for weeding. These labour requirements continue to rise, while competition from other plants may lead to a decline in yields and, by implication, a restriction of the length of the cropping period (Greenland 1974). A point is reached where the labour needed to keep a swidden field clear of weeds will start to exceed the labour needed to clear a new site in the forest (Janzen 1973; Nye and Greenland 1960; Sanchez 1976; see also Rambo 1983 and Staver 1989).

But not all weeds are the same. Weeds are perceived as an inevitable part of the agricultural landscape (Alcorn 1989). Not everything that appears that was not planted is perceived as a "bad" weed. Selective weeding is utilized throughout the tropics by swiddeners. Research in the Amazon has shown that half of the plant species growing in a swidden may not have been planted, but were either in the field before clearing or appeared while the field was being utilized (Balée and Gély 1989). If a plant is useful it is "spared or protected . . . the decision depends on the biology of the species, the amount of plant material needed, and the individual's thought on the matter" (Alcorn 1982: 401). Such a volunteer or "wilding" is a bonus for the swiddener since with a minimum amount of work a plant is in a useful position.

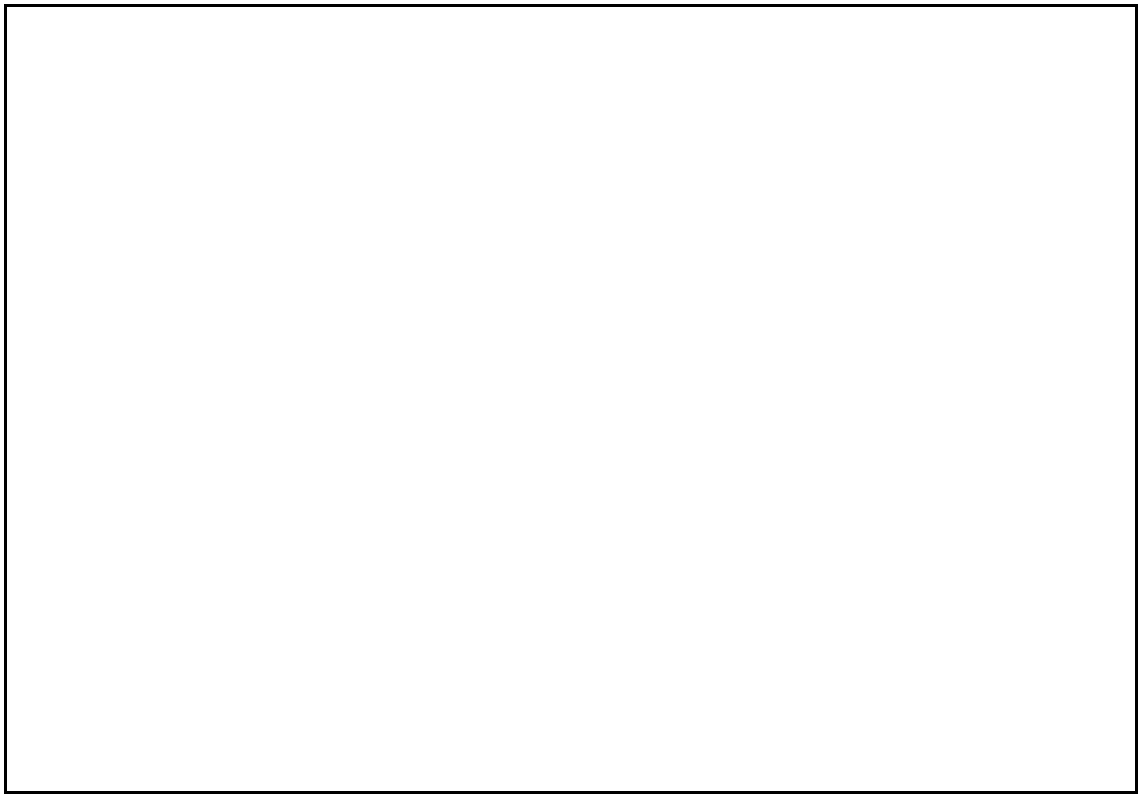
Existing trees may be coppiced rather than removed, especially trees that are useful, but slow growing. Seedlings of useful trees species may be protected so that in future years they can be harvested for their fruit, fiber, etc. or for the attraction their fruit will have for animals that can be hunted (Denevan et al 1984; Clay 1988). Trees that appear in a mature forest might be left as seedlings so that the forest can be reestablished (Olafson 1983). Nevertheless, woody pioneer species and primary forest seedlings may decline during the repeated weedings of the field as a result of efforts to stop them from competing with the domesticated crops . Uhl (1983) found in the Amazon, where manioc intercropped fields were used for several years, that weeding several times annually created a shift in the natural vegetation of a swidden. There was decline in tree and shrub species with a definite shift toward herbaceous growth as the dominant weed. The reason for this was the ability of herbs "to germinate, flower, and set seed between weedings and therefore build up high plant densities and large seed stocks" (Uhl 1983: 75 - 76). Once herbaceous growth is established weeding has to intensify, or else the decision has to be made to leave the field to succession and clear another.

One of the disadvantages that a swiddener experiences is pests. While the permanent field farmer, surrounded by fields growing the same crops, has to worry about epidemic diseases, the swiddener has a constant concern over birds and animals raiding his fields (Poulsen 1978: 23). The goal of the swiddener is two-fold: to stop the destruction of the field and, if possible, to get the animal for the pot. Mammals of the forest can be particularly destructive to crops. In the Amazon peccaries are especially destructive (Carneiro 1983, Johnson 1983). To counter the threat of the peccary the primary management technique is site selection, for the swiddeners themselves believe that dispersal of fields limits animal predation (Johnson 1983). Within the field, rings of bananas and plantains may be planted on the periphery to discourage animal predators (Beckerman 1984), or crops that are most vulnerable to predation will be placed in the center of the field (Stocks 1983, Balée and Gély 1989).

So, although game animals are encouraged to enter the swidden *fallow* by man-made attractions of fallen fruit and edible roots, the swiddener is engaged in a constant struggle to keep his *current* field pest free. The struggle can be a serious one if the swiddener is surrounded by forest, as in the Amazon, or, in Africa, by open woodlands. The mature forest sites that are preferred for swiddens provide good cover and allow animals to enter the fields when there is no one to scare them away. In response to the predation of pests the swiddener builds watchhouses, sets traps, makes scarecrows, fells trees that harbor nests, constructs fences (Carneiro 1983) and spends hours waiting . . . waiting.

Birds, such as the African weaver bird, can strip a field of rice and millet. In many swidden societies older children in the family are used as the bird scarers, a task that requires hours of waiting yet little skill, so that adults can pursue other activities.

Researchers who have tried to do field trials in the tropics have met with the same problems as swiddeners in crop protection. Nye and Greenland (1964) note the near total loss of a test plot of cassava and cocoyam (taro) to cane rats; and Maass et al (1988) estimated 80% of a test plot of maize was destroyed by a herd of peccaries (Tayassu tajocu Alston).



Harvesting rice in Southeast Asia

Harvesting, yields and processing

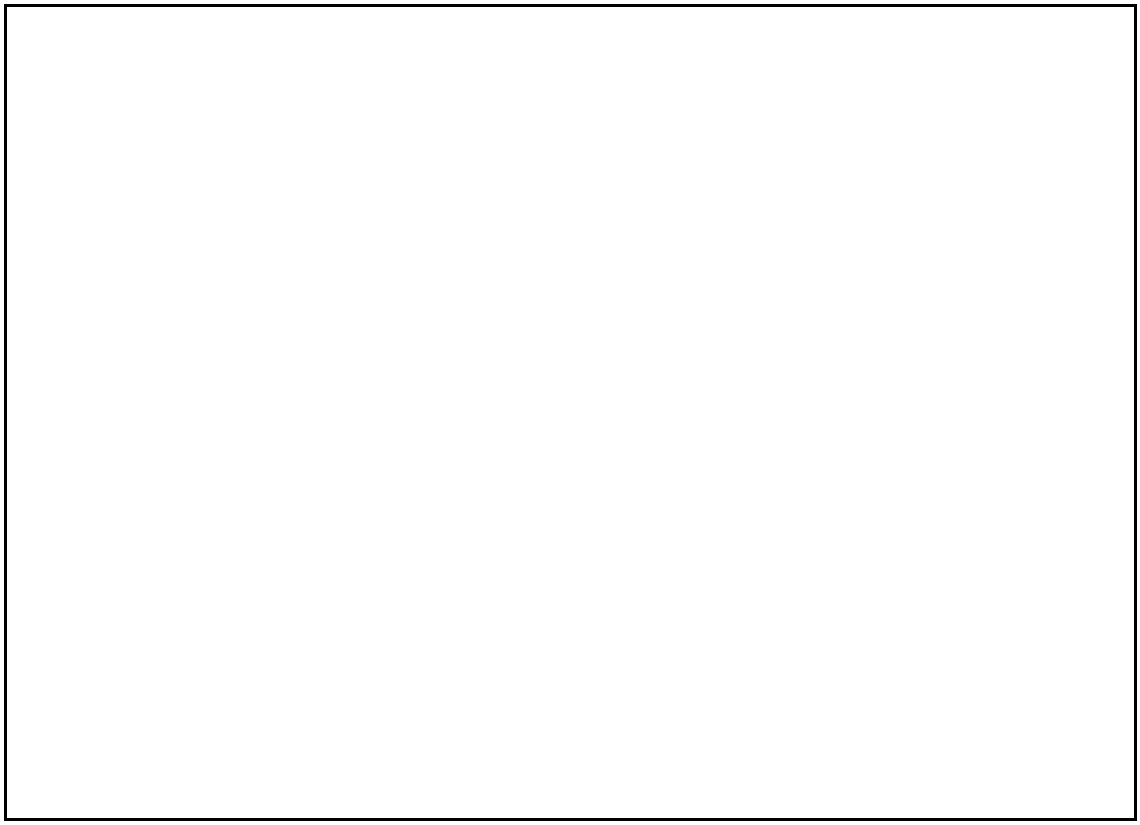
If the swidden has been planted with many crops of different varieties, each will be harvested as it matures. The harvest period of seed crop (rice, millet, maize) is less flexible than root crops. One of the advantages of root crops, especially cassava, is that they can be "stored" in the ground and harvested as needed. Crops such as maize and rice, however, have to be harvested relatively quickly and then stored. Even so, labour peaks can be avoided if different varieties of the seed crops, some faster maturing than others, are planted at different times. The diverse varieties will then mature and be ready to harvest over a period of weeks, even months, rather than days (Warner 1981). The advantages of a diversity of fields, crops, and planting sequences carry through the entire system from field site selection to harvest.

Yields vary in response to weather, crop selections, labour inputs, disease, pests, and field sites. Yields will usually be greater on a site cleared from mature forest because of the better burn, fewer weeds, etc. Some crops, such as rice, show a decline in yields with successive plantings, others, such as cassava, appear little affected (Nietschmann 1973). Even if yields decline with successive plantings, the labour required may also decline so that a net gain still occurs. At a site in Central America it was found that second year agricultural fields provided only 40 - 50% of the calories that could be harvested from a new field, but with only 30% of the labour input (Nietschmann 1973: 148).

The main goal of the integral swidden agroecosystem is, through the combination of fields, crops and labour, to produce sufficient cultigens for subsistence. Such systems produce what has been called a "normal surplus" since the system is geared to producing a sufficient harvest of cultigens in a year of poor yields. "Consequently, there is a surplus in the "normal" year, none in the poor year and a shortage or famine in an unusually bad year" (Allan 1972b: 222). Yet even in an unusually bad year there are other subsystems to be

utilized within the agroecosytem of forest swiddeners. Hunting, fishing and gathering can be intensified until the next harvest of cultigens. It is these other options that give swidden agroecosystems their stability and sustainability.

Some cultigens require little in the way of processing. Potatoes and sweet potatoes, for example, need only to be harvested and prepared by roasting or boiling. Others require hours of labour before they can be eaten. Cassava, because of its poisonous content, has to be grated, squeezed, and then made into a flat bread in Latin America or a porridge in Africa. Rice is labour intensive as well. After harvesting, rice has to be carried to the house or granary, threshed and stored. The threshed rice has to be kept dry or it will spoil. Throughout the year, a village will be dotted with mats covered with rice, as each household rotates its stored rice through the drying cycle. Threshed rice still has to be husked and cleaned. However, since husked rice does not store well, it is usually prepared in small batches on a weekly, even daily basis, so the labour demand for husking and cleaning is dispersed throughout the year.



Natural succession results in forest regeneration if the field has not been used for too long or is not too large.

Succession and rotation

If a swidden agroecosytem is to continue, the old fields have to be allowed to become part of the forest again (Moran 1981: 55). In the humid tropics, natural succession results in forest regeneration if the field has not been used for too long a period or the field is not too large (Manner 1981: 372). But how long will a forest succession take? What are its mechanisms?

In an Amazonian study it was found that initially the field site was colonized by herbaceous annuals, but after one year pioneer woody species began to shade them out. These pioneer woody species were seeded from the adjacent forest. Aiding in the establishment of the woody species are microhabitats (microsites), e.g., fruit trees and logs, that provide a favourable microclimate for the seedling (Uhl 1983; Wilken 1972). The fruit trees themselves serve as a center for seed dispersal, since birds and bats are attracted to them and void seed while feeding. The shade of the trees protects the seedlings from the direct sun, and in time these "islands of woody vegetation" expand till they touch each other and the former field site is covered by the secondary growth. These early trees die after 5 - 10 years and are gradually replaced by the slow-growing forest species. Uhl estimated that

it would take 100 years for the field sites to revert to primary forest, and stressed the importance of the microsites of trees and logs in the reestablishment process (Uhl 1983: 75 - 78).

What role does the swiddener play in the regeneration of the forest? Until recently the prevailing view was that the swiddener "just let nature take its course" and "abandoned" the swidden to let it regenerate. This view is currently being questioned as studies have revealed the active management applied in shaping fallow succession. For example, in the study cited above, it is the fruit trees planted/protected by man that enable the woody species to become reestablished in a swidden field (Uhl 1983). Since it involves "a combination of annual crops, perennial tree crops, and natural forest regrowth" this manipulation of swidden fallows is now being recognized as a form of agroforestry, referred to as "traditional" or "indigenous" agroforestry (Denevan and Padoch 1988a: 1; see also Olafson 1983; Denevan et al 1984; Padoch and de Jong 1987).

The importance of preserving trees in the field is recognized by many groups, although it might be for their immediate use in the field (fruit, support for vines, microclimate for plants needing shade, etc.), for forest regeneration, or as an attraction for game in the future, rather than for the prevention of soil erosion (see Wilken 1972; Conklin 1957; Geertz 1963; Watters 1960; Vermeer 1970; Harris 1976). The swiddener may actively manipulate the succession so that certain desired trees will become dominant. This can be done by selective weeding or, more rarely, planting favoured trees, so that a favoured succession can be established.

The Siane of New Guinea, for example, encourage the growth of the casuarina tree by weeding their garden sites so that the kunai grass will not crowd out the young casuarina seedlings. This selective weeding helps forest tree seedlings that have become established to survive. The casuarina in the gardens are usually "volunteers", but seedlings will be planted in areas in which they do not spontaneously appear (Olafson 1983: 156 - 157 cites Salisbury 1962: 43). Such selective weeding initiates the basic pattern of succession of productive swidden fallows.

Even though the planting of trees for enriched fallow is relatively rare when compared to the almost universal pattern of management of preexisting vegetation or volunteers, it does occur. In Nigeria, for example, the Ibo plant Acioa barterii and the Iboibo Macrolobium marcrophyllum beween yam and cassava plants to quicken the fallow. Also in Nigeria, Glicidia sepium, believed to shorten the necessary fallow to two years, is used for yam stakes, which sprout and become established in the fields (Benneh 1972, Weinstock 1985, Getahun et al 1982). The low frequency of planting versus managing may be tied to the perception of available resources. With integral forest swiddeners there is the desire to increase the diversity of resources and encourage a succession of useful plants in the fallow. Rights to harvest are given to those who cleared and planted the field. Once the succession has reached a certain phase, however, usually after 10 or more years, these rights may gradually dissipate or become meaningless, especially if there is a large reservoir of suitable land to be used for future fields, or if the village is moved or household residence frequently shifted.

However, this is in the instance of improved fallow, not in the case of planting cash crops. In Africa, where cash crops are already prevalent and land scarcity felt, rights to land are more formal, and more in dispute. The Nigerian farmer who plants the shrubs as a fallow establishes his right to use that land for cultivation -- the land will not be fallowed long enough for forest to establish, nor for it to return to the potential swidden "pool" (Benneh 1972).

Although different swidden groups in different regions developed locally favoured patterns of succession, the basic process is similar: by selective weeding and, in some instances, tree planting, to create a succession that will be useful through all of its stages. It is a strategy "designed to serve a shifting cultivator's dilemma of how to maintain field production in the twilight of the cropping cycle, while at the same time permitting forest regeneration" (Denevan et al 1984: 349, Harris 1976).

This active management has to some extent been overlooked until recently because of the perceptions of those outside the swidden agroecosytem. Swidden fallows were referred to (and still are) as being "abandoned", a term that gives the impression that the field site will neither provide anything of further use, nor that the swiddener will have anything more to do with the site. Little attention was paid to the swidden fallow and its management because of this lack of understanding (Padoch and de Jong 1987: 179). Rather than being abandoned, a swidden moves through a progression from a field "dominated by cultivated plants to an old fallow composed entirely of natural vegetation" (Denevan et al 1984: 347). This entails a transformation of the field from producer of cultivated vegetables to producer of animals, building materials, medicinal plants, etc. (Beckerman 1983: 7). The management applied to swidden fallows may be aperiodic and informal (Padoch and de Jong 1987: 180), and

easily overlooked by researchers who are in the community for only a year or two. Yet the impact of swidden management cannot be overlooked.

The biotic components of the fallow are selected through protection of volunteers, planting and weeding, and the forest that results is largely anthropogenic (Denevan et al 1984; Nigh and Nations 1980; and Gordon 1982: 73 - 78). The swiddener actively manipulates the natural process of succession to include more useful species than would occur during a "natural succession " (Irvine 1989). Such forest management involves 'intermediate disturbance", with the forest neither destroyed nor unutilized, and makes possible the sustainable use of resource zones in different stages of forest reestablishment and maintenance (Nations and Nigh 1980, Denevan and Padoch 1988). During its succession to forest the field continues to provide fiber, vegetables, medicinal plants, etc., and is a necessary and integral component of the agroecosystem (Hoskins 1982).

The result of this resource management is the existence of extensive anthropogenic forests. The tropical forests, once thought to be "virgin" forests (never cut), are now perceived as being "mature" forests that were once farmed by man. Spencer (1966) suggests that the mature forests of Southeast Asia are probably not virgin, as does Richards (1973b) for Africa, while Denevan et al (1984: 347) suggest that "in the past large areas of the Amazon forest may actually have been stages of productive swidden fallow." Tropical forests show evidence of having been manipulated, both in the diversity of species that are useful to the inhabitants of the region and in the finding of clusters of trees that would not occur in a "natural" succession (see Denevan 1984, Getahun et al 1982, Benneh 1982, Okigbo and Lal 1979).

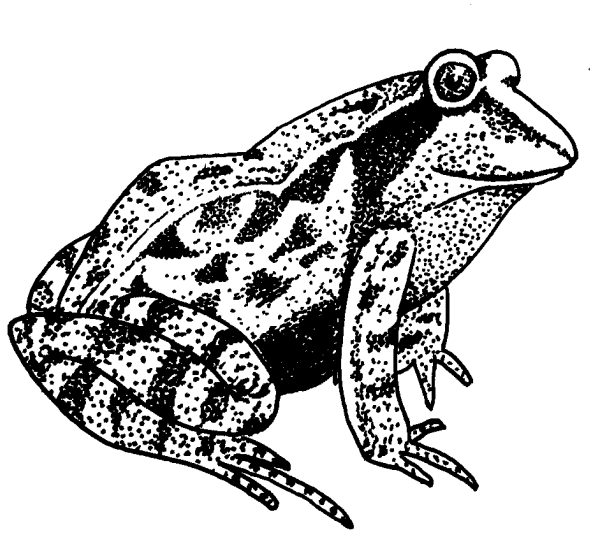
Some forests would not exist without human intervention. Groups such as the Kayapo have actively created forest islands to serve as sources of food and shelter when on treks in the savanna. After choosing a small depression in the savanna that retains rainwater, the Kayapo carry mulch to the site and mix it with crushed termite and ant nests. These mounds are used for planting seeds, seedlings or cuttings. Gradually these islands are expanded with more mulch and plantings until extensive forest islands exist in the savanna. These islands are completely cultural artifacts, since without the Kayapo management they would not exist (Posey 1984, 1985, Anderson and Posey 1989). Even if indigenous management techniques are subtle, their effects are not.

In summary, the swiddener perceives his field as a "forest gap" that will gradually return via succession to forest. By planting or protecting favoured species in the field, the succession will include plants of greater use to the swiddener than there would be in "natural" succession. The return to forest is desired, for without it the area would no longer be part of a future swidden cycle. Therefore the swiddener's goal is not to destroy but, through clearing and then managing the succession back to forest, to obtain a continuous harvest of cultigens on the way to a new forest of rich diversity, containing stands of trees that are highly valued.

RESOURCE MANAGEMENT: HUNTING AND FISHING COMPONENTS OF THE AGROECOSYSTEM

Theoretically, the integral swiddener has a diverse range of resource zones for exploitation: fields, fallows, homegardens, forests and, in some settings, small rivers and ocean coastlines. In Southeast Asia there may also be extensive stands of cash crops such as rubber, coffee, pepper and poppy. Wet rice fields, sometimes recent, sometimes longstanding, may be utilized in addition to the swidden fields. In Africa, cash crops such as cocoa, coffee, rubber and oil palm are almost universal. As a result of higher population density and large areas under cash crops, most swiddeners have "in-fields", which are intensively cropped, and "out-fields", which are still under some sort of fallow system. The decline of forest resources in Africa has created a push for further intensification and greater involvement in cash cropping. In the Amazon, especially in areas far from contact, the wide array of resource zones still exists and is still exploited.

Tropical forest and savanna populations make use of gathered protein that could easily be overlooked by Western observers since it is not part of the Western diet. In Africa, for example, termites are commonly eaten roasted and are an important food, high in both protein and calories (Mielke 1978, Bodenheimer 1951, Miracle 1973). Significant amounts of time can be spent in catching termites: Schlippe (1956) estimated that the Azande spent 26% of their work effort during the rainy season in catching them. The swarming of the termites occurs during the first rains and is a source of food when food reserves are low.



Grubs, termites, ants, frogs, etc., are gathered and eaten with relish throughout the Amazon. The Desanâ of Brazil, as do other groups, eat insects and insect larvae as an important part of the diet, especially during the periods of the year when the rivers are too muddy to fish (see Figure 11). Although "gathered," their presence may be actively encouraged through the creation of favoured habitats, e.g., planting trees such as Ingá spp. (Leguminosae) on which insects lay their eggs, and the preservation of termite and ant mounds (Dufour 1983, Ribeiro and Kenhíri 1989). Habitats to attract egg-laying insects (e.g., dead banana plants, maize cobs) may be created, and the grubs harvested when ready (Denevan 1971).

Hunting and fishing are important components of the agroecosystem. Although there is disagreement over how serious a problem it is, the lack of protein in the Amazonian cultigen diet is perceived as a potential constraint that must be overcome. The projected protein deficiency is based on the low nutritional content of manioc, the staple of the majority of the indigenous groups, which requires the exploitation of other components of the resource base -- hunting, gathering and fishing -- to maintain dietary protein sufficiency (see Sponsel 1989). The predominant pattern is for the carbohydrates to come from the "on-field" and the proteins from the "off-field" components of the agroecosystem, in a successful utilization of the resource base.

Hunting is easily integrated into the swidden cycle. Swiddeners utilize the attraction of their swidden fields and fallows to lure game. In the humid tropics population density of mammals is usually low. The fields and fallows, however, attract and support higher densities of game than would otherwise occur. The small dispersed fields of the swiddeners create "natural corridors" in the forest that serve as a reservoir for plant and animal species. The combination of fields, fallows and forest stimulates the growth of wildlife and improves the natural resources, e.g., the forest mammals, of the swiddener (Linares 1976, Ross 1978, Gomez et al 1972; Lovejoy and Schubert 1980, Posey et al 1984).

In Southeast Asia, the highland rivers are too small and in some instances too high in the hills to be a rich resource for fishing. Therefore, except for a few swidden coastal people, the pattern in the region is for reliance on hunting rather than fishing. Keeping dogs for hunting pig is common, although the degree of care that the dogs experience varies. Domestic animals such as goats, sheep, pigs and horses are more prevalent on the mainland than on the islands, although feral pig may be hunted in areas where domesticated pigs are not kept or eaten (Spencer 1966, Warner 1979).

In the Amazon basin, the Yanoama, Achuara, Ye'kwana, Yukpa, Kayapó, Ka'apor, Sirionó, Bora, etc., all hunt in their swiddens and fallows. Old fallows, where there is mixture of forest, old cultigens and fallen fruits, are recognized as the best of hunting grounds -- the animals are less wary and blinds can be built that are not easily seen (Smole 1989, Chagnon 1983, Ross 1978, Hames 1983c, Ruddle 1974, Posey 1985, Balée and Gély 1989, Balée 1989, Holmberg 1950, Denevan et al 1984).

Figure 11. Desanâ fishing and gathering calendar

Constellation*	Weather	Fishing and gathering
OCTOBER		
Pit Viper[1]	Heavy rains	Gather mushrooms
NOVEMBER		
Pit Viper, round, tail	Heavy rains	Gather mushrooms
DECEMBER		
Pit Viper, round, tail	Heavy rains (floods)	1st fish spawning Frog capture 1st termite flight
JANUARY		
No constellation	Dry season - 5 days long	
	another dry season: *inga*[2] summer occurs toward the end of the month : 8 - 15 days	
Armadillo, femur	Rains not heavy enough for flooding to occur	Frog capture
FEBRUARY		
Armadillo	Rains	2nd fish spawning
MARCH	*cucura*[3] dry season - 4 days long	
	light rains	
	followed by two weeks of dry season: *peach palm* summer	
APRIL		
Shrimp	Not always rain; when this occurs, *peach palm* summer continues until mid-April	3rd fish spawning
Jaguar, chin	Heavy rains; flooding	
	2 or 3 sunny days interspersed with rain	
Jaguar, body	Heavy, intermittent rains	
	4 -5 day dry season: *Umari* fruit dry season	Flight of: termites, "nocturnal" and leaf-cutter ants
Jaguar, tail, round	Heavy rains	End of frog capture, fish spawning, ant and termite flight
MAY - mid JUNE		
Star, piece	Intense, constant flood rains	
Fish, smoked	Intense, constant flood rains	

Gourd with *umari* pulp on a stand	Intense, constant flood rains	Hook and line fishing Termite flight Edible larvae, that cling to Cunuria spruceana, Euphorbiaceae; eat Sterculia sp., Sterculiaceae leaves
JUNE		
	Three day dry spell	
Adze feathered ornament	Rains	Capture of tiny fish Edible larvae continue to be gathered
JULY		
Otter	Rains	Grasshopper flight (capture with bare hands)
Birds, very pretty	Rains	
Crab, very pretty	Rains	
AUGUST		
Star, piece	Rains (rivers high)	Edible larvae, that eat the leaves of Erisma japura, Vochysiaceae; the caterpillar that eats leaves of the Minquartia guianensis, Olacaceae; caterpillar that eats *ingá* leaves (which is why *ingá* tree is planted near fields and inside village) Hunt pacas (Cuniculus paca)
SEPTEMBER		
	2 - 3 dry days: larva, old summer	
	Rains	
	5 day dry spell: larva, pretty, summer	Last larvae eaten
Crane, flood	Rains	Last flight of the termites
	5 day dry spell: thorn, summer	

Note: *The names of the constellations are the same names given to the rains that occur during the time they are visible, e.g., the rains that occur during "pit viper tail" are "pit viper tail rains".

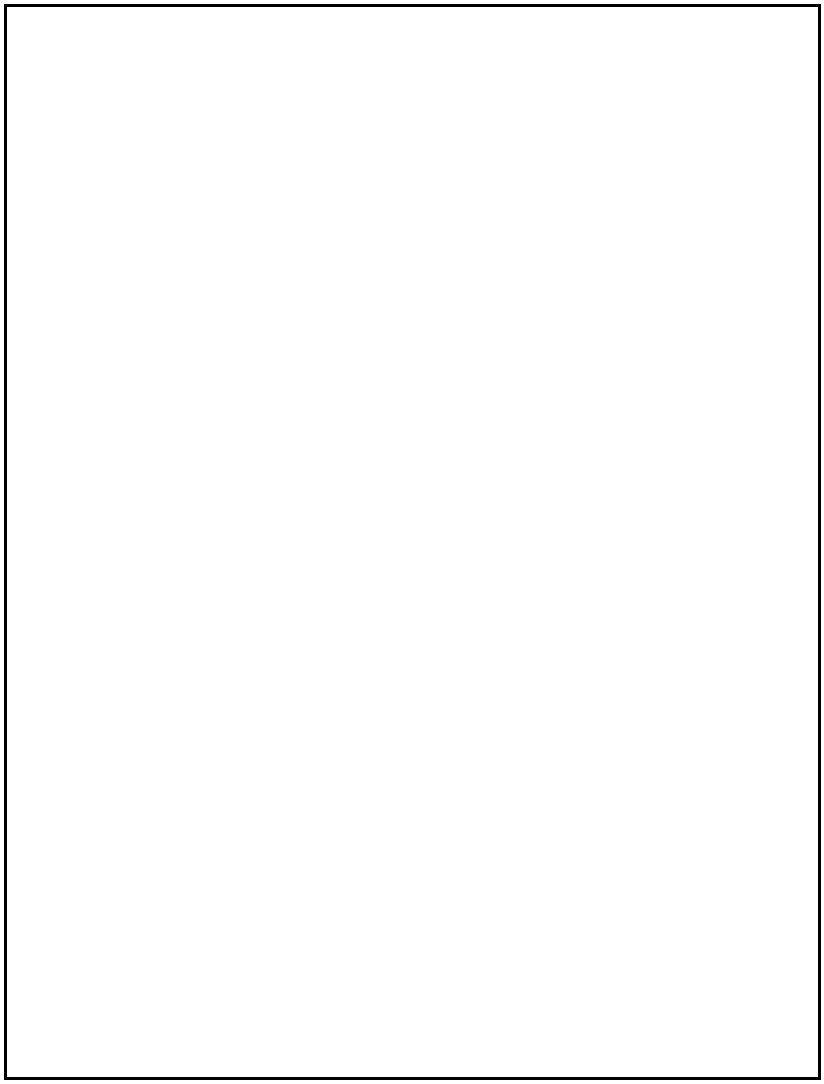
[1] Transforms from Pit Viper Illumination to Head, then Body, then Eggs of the pit viper.

[2] Inga is a fruit that is gathered during this time and eaten (Inga spp., Leguminosae).

[3] Cucura is a fruit that is gathered during this time and eaten (Pourouma cecropiifolia, Cecropiaceae).

Source: Ribeiro and Kenhíri 1989

The reliance on game/cultigens is a longstanding pattern in the Amazon. Yet overexploitation does not seem to have occurred; there appears to have been purposeful conservation of animal resources (Roosevelt 1989). Indigenous groups currently do practice, usually through food prohibitions related to myths and religious beliefs, some measure of control over hunting (Ross 1978). The religion of the Desanâ and Tukano of the northwest Amazon, for example, promotes belief in a finite circuit of energy on which the fertility of both animals and man is dependent. It is recognized that too many humans would unbalance the entire energy system and there would be a decline of animals through overhunting. To maintain the balance, the Tukano limit their family size through sexual taboos and limit the frequency of hunting by specific ritual observances. They perceive their environment as man-made, "not so much by any exploitive activities of their ancestors, but by being imbued by them with symbolic meaning." Their religion supports them being actively involved in the *maintenance* of their ecosystem by limiting their numbers and their predation (Reichel-Dalmotoff 1977:5, Bodley 1976, Lathrup 1970).



Fishing in the Amazon basin

Management of fishing resources in the same area is also found. The rivers of the Amazon basin are designated as white-water, black-water and clear-water rivers. These designations are based on the sediments they contain, their color, clearness, and nutrient levels. The Amazon and some of its tributaries are white-water rivers, carrying sediments from the Andean headwaters. They are rich in nutrients, but their turbulence and opacity limit the primary production of phytoplankton. Black-water rivers are dark due to dissolved humic matter, transparent,

nutrient-poor and acidic. Clear-water rivers are similar to black-water rivers in nutrients, but do not have the dark coloration since they do not contain dissolved humic matter (Hames and Vickers 1983:4).

Tukano groups that are dependent on fishing manage their aquatic resources as similar groups dependent on hunting manage their animal resources. The Uanano Tukano reside in the Uaupés River Basin, a blackwater floodplain noted for the lack of nutrients in the river and surrounding soils. Blackwater rivers do not contain the necessary levels of nutrients for the production of large amounts of primary phytoplankton, i.e., there is a limitation to fish production if solely dependent on the primary production at the bottom of the food chain. These rivers, however, have another source of nutrients, the "terrestrial fringes" of the river, which provide nutrients for the fish via leaf and coarse litter, insects, fruits, seeds, etc. These nutrients enter the river primarily during the periodic flooding that occurs. When the rivers rise, the fish disperse onto the flooded forest and "feed on the abundant foods that become available." The Tukano are aware of the relationship between the forest and the fish and never cultivate the terrestrial fringes, which "are reserved as feeding grounds belonging to the fish" (Chernela 1989:242).

Management of the fisheries is an integral part of Uanano religious beliefs:

> "Nature is abstracted as a series of brothers, reactive and generous when treated with respect, but vengeful and punitive when treated with arrogance; . . . peaceful, ordered exchange . . . is tolerated . . . but . . . gluttonous interference is avenged by dangerous fish guardian elders. Relations between man and the natural world are harmonious so long as the proper limits are maintained " (Chernela 1982:17).

The Uanano, by maintaining the forest fringes, perceive themselves as entering into a reciprocal relationship with the fish that allows them to exploit but not overexploit their vital fisheries. In a region of poor soils and nutrient poor rivers they have created an agroecosystem that is sustainable and productive.

Traditionally when the "out-field" components of the agroecosystem were depleted, the swiddeners response was to move elsewhere. In Africa, the commitment to cash tree crops is dependent on permanent residence, so farmers no longer have the option of moving to other areas. Although there may be continued reliance on the "bush" (secondary forest or mature fallow) for game and collected goods, this resource base is in decline as population pressure on the forest and wildlife increases (Okigbo 1982). That which was in the not too distant past collected or hunted is now purchased, increasing the dependency on cash crops still further.

In summary, integral swidden as practiced by indigenous people throughout the tropics is the major component of a complex agroecosystem which relies not only on agriculture, but also on hunting, forest collection and, in some areas, fishing. Natural resource management is focused on making use of natural processes to maintain the diverse forest ecosystem rather than permanently simplifying it by human interference. The forest may be cut, but, by clearing small dispersed sites, selective weeding, and planting or protection of trees, the forest is aided in its return. The swidden field is perceived not as an autonomous entity, but as the first stage in the transition back to forest.

Other resources such as the animals and fish are also managed within a worldview that looks beyond the immediate use towards future sustainability. Well nourished, not protein deprived, populations live in a stable relationship with the natural environment, actively managing their agricultural, gathering, hunting and fishing resources. It is not a rigid adaptation, but one that is flexible in response to changes in the environment or to shifts from one locale to another (Hames and Vickers 1983).

Chapter 4

Conclusions

Shifting cultivation has been an extremely successful adaptation to the rigors and constraints of the humid tropics. In an environment of fragile forests and soils, the integral swiddener has developed an agroecosystem that is diverse, flexible, and able to respond to environmental uncertainties. To return to the questions posed at the beginning of this note:

What do they know? The swiddeners have an intimate knowledge of both the surrounding environment and the microsites of the fields. The natural process of forest regeneration is understood: small fields will act as forest gaps and quickly revert to forest; trees and plants that are spared and protected during cutting and burning will quickly grow or resprout to become the first stage of succession to forest. Swiddeners also appreciate the diversity of microsites that can be found in a field, and perceive it not as a problem, as would the monocrop farmer, but as an opportunity to develop each of the microsites as a unique "microfield".

What do they do? The swiddener utilizes this knowledge of the natural environment not only to make swiddens, but also to successfully gather, hunt and fish to provide food, fiber and medicine for the household and sometimes for the external market. Knowledge of both the natural environment and the needs of the tropical crop repertoire is utilized to develop and manage the microsites of his fields. He matches specific crop needs to specific soils -- a diversity of crops meshed with a diversity of microenvironments.

Why do they succeed when others fail? Western agricultural technology is based on the knowledge derived from temperate climate agroecological systems. These agricultural systems are based and dependent upon large fields, humus-rich earth further enriched by chemical fertilizers, pest protection based on expensive chemical sprays, and monocropping based on market prices, and government supported extension services and prices. These variables are very different from those with which the tropical farmer deals. That the tropics have not been responsive to temperate agricultural methods should not come as a surprise. The very reason that swiddeners succeed is by accepting the tropical ecosystem and making it work for them. Rather than attempting to "conquer" the tropical ecosystem, the swiddener chooses to manipulate the natural processes of the tropical ecosystem so that it pulses through a stage that is highly productive for him as it returns to forest. Too much of the effort of agricultural development has been expended in trying to make the tropical agroecosystem fit into the mold of the temperate agroecosystem. Since the tropics will never be temperate, what is needed is an agroecosystem that is realistic for the tropics.

SUSTAINABILITY

Implicit in the analysis of the integral swidden agroecosystem has been its *sustainability***.** Sustainability has become a major concern in agricultural development in recent years. The issue of sustainability requires a different definition of a successful agricultural system than a count of the number of bushels harvested. It requires a future orientation: how long and with what inputs can the yields continue? What will be the future effect on the environment of present day agricultural techniques? Will the proposed improvements benefit one segment of society and penalize another?

There has been increasing concern that if the high input agricultural systems of the temperate zone cannot serve as models for tropical agriculture, what alternatives are there? The "development of self-sufficient, diversified, economically viable, small-scale agroecosystems . . . adapted to the local environment that are within the farmers' resources" is not going to be easy (Altieri et al. 1983: 48 citing Loucks 1977).

Although integral swidden has been a sustainable agroecosystem in the past, it cannot serve as the model for the future of the tropics. Regeneration of the forest is crucial for the long-term productivity and sustainability of the swidden agroecosystem, and many swidden groups are no longer able to fallow their fields for the necessary period of time. It is not because the link between forest, soils and productivity is no longer recognized by the swiddeners, but because they are in a situation that makes the continuation of the forest fallow impossible. The primary reasons for the shortened fallow are classification of fallow land into forest reserves or logging concessions, population growth, in-migration and the impact of cash crops.

In many instances, all of these factors are interlinked. The integral swidden community, for example, may experience a constriction of its resource base as forested areas are reclassified by national authorities and reassigned to other sectors, or laws prohibiting settlements from remaining in the forest reserves are enforced. It is not uncommon for swiddeners to be moved to a new site, far from their current fields and old fields in different stages of production.

NEW STRATEGIES

The integral swiddener has to develop new strategies to transform the successful agroecosystem of the past into a new system that will be sustainable in the future. The challenge is in developing tropical agroecosystems that build upon the knowledge of the integral swiddener and can be utilized by small farmers, not for a few years, but for generations.

Much of the local technical knowledge of swiddeners is too area specific or too tied to indigenous religious systems to be readily transferable to other societies. There are, however, some general principles that underlie the local technical knowledge of the swiddener and are applicable not only to the intensification of shifting cultivation, but also to the development of other tropical land use systems.

1) *Integration of trees into the agricultural system*
   Forest is perceived by swiddeners as the beginning and end of the agricultural cycle. Swiddeners actively manage their fields so that they will return to forest. As forest resources decline, protection of trees within the field in some areas may become supplemented by planting trees. The planting of trees will have to be increased as forests recede. Since a diversity of trees were protected in the fields and utilized in the forest, a variety of trees will be needed to replace the "naturally" occurring forest products.

2) *Utilization of microenvironments, microsites, multicrops and multivarieties*
   Swiddeners appreciate and exploit differences in the environment, sites within the field, and crops. This fine tuning of diversity helps create the stability of the swidden agroecosystem. This principle can be utilized in the development of other land use systems. Smallholders in the tropics, whether swiddeners or permanent field farmers, have an intimate knowledge of their fields and can utilize this knowledge to integrate new crops, especially trees, into their fields. New crops and methods are a continuation of management practices that identify and match microsites to specific crop needs.

3) *Stability maintained by the many components of the swidden agroecosystem*
   In integral swidden, the current field was only one component of the agroecosystem. Fields in different stages of regeneration, hunting, fishing, gathering and, in some instances, cash crops and wage labour were all components of the greater system. These different components could be utilized as needed in response to fluctuations in the natural ecosystem, household needs or external pressures. Currently the resources of the past are becoming inaccessible or even eliminated. However, the *principle* of a multicomponent agroecosystem can be maintained, but it requires the development of more on-farm components, such as domestic animals and further development of homegardens, with less reliance on the resources of the forest.



THE ROLE OF GOVERNMENT AND DONOR AGENCIES

Government and donor agencies in many countries have continued to maintain conventional attitudes in the management of tropical forests. Management is perceived in terms of protecting forest reserves, while the needs of the communities dependent on the forest resources may be ignored. It is a reactive rather than a proactive approach, and usually does not work. If people need the forest resources where there is little in the way of alternatives, the forest will be utilized.

More research is needed, not only on swidden, but also on forest utilization and management practices. If forest reserves are to be maintained, the use of the forest by neighbouring communities must be studied. This research could be combined with on-farm research in swidden societies. Swiddeners should be *active participants* in designing new agroecosystems that are sustainable when forest reserves decline or become inaccessible.

Smallholders in the tropics have management needs and skills that should be studied within the context of their communities. On-farm research would be another step away from the monocrop approach of the past towards an attempt to help small farmers, whether practicing integral swidden or cultivating permanent fields, make better use of their fields and other resources.

Agricultural and forestry extension agents should be trained to recognize that integral swidden can contribute something of value to agricultural development and forest management. While this recognition is long overdue, the integral swiddener continues to be blamed for massive deforestation. There is still prejudice against swidden practices as being "primitive" and reflecting the "unscientific" nature of the swiddener. The general principles of swidden systems are not primitive or unmodern. The integration of trees into the agroecosystem, utilization of microenvironmental differences, and maintenance of a multicomponent agroecosystem can provide a useful framework for the further development of smallholder agriculture.

In summary, integral swidden is a successful adaptation by men and women within the forest ecosystem. It has a long history in the tropics and was sustainable when population densities were low enough to allow the reestablishment of the forest in swidden/fallow fields. In many areas of the tropics man manipulated the forest regrowth to create an anthopogenic forest reflecting his particular preferences and needs.

Currently there is increasing competition for the remaining tropical forests. As international pressure mounts, swiddeners, rarely members of the national mainstream, will find it difficult to maintain control of the forest areas, long used within their systems. However, the general principles of swidden management practices, based on the local technical knowledge of swiddeners, can be combined with on-farm research in swidden communities to develop new methods and techniques for agricultural development in the tropics.

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