Huanca, Tomás. Tsimane' indigenous knowledge, swidden fallow management, and conservation. Ph.D. Dissertation, University of Florida. 1999.

CHAPTER 1
INTRODUCTION

The current research is concerned with the swidden-fallow management system of the Tsimane' (pronounced Tshee-MAH-nee) in the Amazonian region of Bolivia, South America, using perspectives from anthropology as the basis of human understanding, agriculture as the means of achieving human sustenance, and ecology as the foundation of all living systems. The research, based on field work conducted during a 16-month period from 1997 to 1999, approaches applied anthropology from an indigenous perspective. It specifically focuses on local resource management in the Tsimane' community of Asunta. I contend that an interdisciplinary framework of research may enhance understanding of multistranded human existence.

The extent to which the Tsimane' swidden-fallow study reveals the indigenous management system relies on what goals we pursue and on how the answers will be useful to meet contemporary human needs. Some may look for answers from an academic perspective and in terms of the "classic" definition of management of the environment, but this approach may not be applicable. First, the Tsimane' system located in a remote area of the Amazon basin cannot easily be equated with modern principles of management systems. Second, we know that indigenous people have lived and "managed" forests for centuries, which makes their knowledge, experience, and perceptions unique. This study approaches swidden-fallow management systems from a perspective of natural resource use, and contrasts indigenous and non-indigenous resource perceptions.

For the purposes of this research, a swidden is defined as temporary cultivation achieved by cutting and burning the vegetative forest cover. Some researchers have referred to swidden agriculture as “slash-and-burn” agriculture, a term that I feel does not give full credit to this system. Fallow is defined as cultivated land that passes to a process of regeneration regarding vegetation and soil throughout the management.

A major theoretical assumption in this research is that native people are, in fact, forest managers and environmentalists, as evidenced by the sustainability of their system. Their knowledge and practices are displayed in daily activities and both knowledge and practice have created the current swidden fallow system. We know that indigenous people are becoming very stratified in spite of having genuine knowledge and being the best managers of natural resources. Also, we know that indigenous systems of natural resource use offer great potential solutions to local communities and to the world. However, the manner in which this knowledge and wisdom about living in the forest have been obtained and learned is not fully satisfactory. Researchers have theoretical frameworks that include indigenous knowledge as a subject, but rarely have situated the data into a socio-cultural context and belief system. Research abounds that forestry systems, plants, and humans, are culturally bounded. The Tsimane’ believe the “empty forest” is also inhabited by invisible beings. Tsimane’ still hold their cultural heritage, which rules their daily behavior, but today they need to confront the other “social realm” regulated by fixed rules and rituals. Those rules and rituals are mostly ignored by objectivity assumptions.

The “social realm” mentioned not only has to do with the invisible forest beings, but other invisible beings that rule the country and the Isiboro-Secure National Park, such as government officials. As the Isiboro-Secure National Park overlaps with indigenous territory now, the Tsimane’, are compelled to interact with official organizations and learn bureaucratic relationships. Although they have a representative organization, they are still likely to be marginalized because of their separate cultural universe and illiteracy. However, as meetings, educational events, and participatory activities are now affecting them, they have become nominally integrated with other groups. They are now learning the national language (Spanish) and are skeptical regarding their future. They are being segregated from their main cultural partners and aggression to their belief system is beginning. They feel that outsiders are hostile. The foods that they share in Isiboro-Secure National Park meetings do not satisfy them because they do not want a diet without plantains, fish, wildlife meat, and *shocdye* (manioc beer). Eliciting these problems may help improve communication with the Indigenous Territory Organization in the Isiboro-Secure National Park.

The importance of this study involves the following aspects of resource conservation and human organization regarding the National Parks, indigenous territory, and the local community of Asunta, which necessarily involves anthropology, agriculture, and environment. First, the indigenous territory demonstrates human diversity in that each group has its particular cultural universe that must be preserved regarding knowledge and management practices. Second, the three groups living in the territory, the Tsimane’, Yuracare, and Mojeños rely primarily on swidden agriculture to which the findings of this study are expected to contribute. Third, coming from a forest background, the three groups demonstrate different adaptation strategies, knowledge, and practices according to their native habitats and cultures.

The Territorio Indígena del Parque Nacional Isiboro-Secure (TIPNIS) considers the study of Tsimane' swidden-fallow management important since they are planning to implement grass-roots development programs in the communities. The management concepts, derived from traditional knowledge and fallow succession, may prove valuable for local resource conservation in the Isiboro-Secure National Park and its buffer zones. In developing countries such as Bolivia, local people tend to intensify biotic impact, since land and forest resources are in demand for swidden agriculture, wildlife, fodder, fuelwood, and other economic activities. Therefore, the study may help to build strategies based on traditional knowledge and local culture to ensure the conservation of indigenous territory, maintenance of local resources, and preservation of group cultural identity.

The Isiboro-Secure National Park has various linguistic, socio-economic, and cultural groups. Biological conservation will be useless if human needs are not satisfied and cultural diversity is overlooked. Local participation is important in promoting grassroots development and conservation, and it is important to explore indigenous people's differences and the basis of their belief system that is committed to forest resource conservation. Throughout history we have seen that it is part of human nature to be aware of "continuity of life and quality of life" (Reichel-Dolmatoff 1996). If the basis of making a living is harmed, the flora and fauna of the Isiboro-Secure National Park will die and conservation will remain an unrealistic utopian concept.

The fields of agriculture and ecology have developed highly specialized standarized research methods and techniques that scientists must follow. My participatory approach used elementary techniques in fallow agriculture and ecology. While samples of soils and plants were sent to the laboratory for analysis, indigenous participation was the primary prerequisite of this research. I included the indigenous perspectives to document their existence and preserve the unique body of knowledge they represent.

The Tsimane' of the Asunta culturally and historically are part of the Tsimane' Maniqui River area. Today, they live in the Isiboro-Secure National Park. They are organized in small-extended nuclear families in a concentrated community with about 30 families. They are monolingual, except for the local authorities who speak some Spanish. They are loosely connected to the national society and do not receive health or educational services from the national government.

The current community is settled on the shores of the Secure River. It is relatively inaccessible: there are no roads, so visitors must arrive via motorized canoe or by air. Recently, however, since the Isiboro-Secure National Park was declared community territory, outsiders have visited the community regularly. The Asunta community has lived in the area for 50 years. Tsimane' elders recall that they came to the Isiboro-Secure National Park area after game and fish first became scarce in the Maniqui area, at some point around the 1950s. In the new settlement they practiced swidden agiculture, hunting, gathering and fishing as the main activities, just as they did in Maniqui.

The newcomers established their houses near the confluence of the Isinuta, Toñas, and Ushve rivers. These three rivers feed into the Secure River. Soon after their arrival, the Tsimane' began to clear the forest for their subsistence. They establish agricultural plots a short distance from the village, and hunt and gather for distances that take up to three days to travel in all directions of the surrounding forests. They also travel outside the village to visit their families who live outside of the Asunta area because the *sobaqui* (visit) is an important cultural custom of the Tsimane' people. They still preserve their culture and practices, by interacting with their ancestors, with the forest beings, and with other *chatedye* (Tsimane' kin).

CHAPTER 2
SWIDDEN-FALLOW LITERATURE AND AIMS OF THE STUDY

Aims for Studying the Tsimane' Community

Tsimane' indigenous fallow management deserves attention not only for theoretical and practical reasons, but also because the Tsimane' are the least integrated and acculturated swidden cultivators in the rain forest of Bolivia. Thus, the advantages of the study are twofold. First, one may find similarities and differences in fallow management among the indigenous people throughout the Amazon, which can be used to support or reject theoretical frames. Second, both indigenous and national political organizations need guidance to manage National Parks and community development, and this study may contribute to their knowledge base.

Recently, at a regional level, community organizations have consolidated their territory and equipped a Centro de Gestión.[1] This organization is attempting to support communities with small productive initiatives (community grassroots programs) to improve family livelihood. They wish to maintain the park without affecting the natural resources, to which end the local organization is looking for support from other institutions. Community organizations have close working relationships with other institutions such as Proyecto de Desarrollo de Comunidades Indígenas de Beni (PRODECIB), Equipo Pastoral Rural (EPARU), Centro de Estudios Jurídicos e

[1] During 1990s, the local community organization built a multifunctional infrastructure in the Isiboro-Secure National Park to assist communities and develop conservation and local resource management programs.

Investigación Social (CEJIS) and Centro de Investigación y Desarrollo de Beni (CIDDEBENI). These institutions are expected to help implement development projects in the communities.

Important Bolivian national sociopolitical reforms have made this research highly relevant at this time. The Land Tenure Law (1996) declared community lands indigenous territory. The decentralization Law (1995) delegates the administration of national resources to local communities and strengthens local political decisions. The Popular Participation Law (1994) recognizes the legal status of community organization and promotes the participation of indigenous communities in national development. These national laws provide support for local development initiatives.

Tsimane' fallow management and knowledge has not yet been documented or studied from cultural or ecological perspectives. Thus, the results of this study will be useful in helping local organizations and governmental programs understand the potential uses of local indigenous resources.

This study presents several unique aspects. First, there are no other studies of indigenous agricultural practices and their impact in the National Parks of Bolivia. Although there is a preliminary study of pasture locations for cattle range (Taborga 1995), there is no study regarding the impact of such cattle ranching. Second, evaluating land and forest use is fundamental for developing and implementing policies that promote sustainability. For example, efforts to develop multiple use buffer zones bordering national reserves, parks and special ecological areas might include swidden agriculture as an appropriate land use option. Third, studies of sustainability may serve in the political defense of indigenous swidden societies (Kleinman et al. 1995) by empowering native rights and organizations in areas where official institutions do not fully respect indigenous territories and farming plots. Fourth, because the Tsimane' are less acculturated than other indigenous groups in the Isiboro-Secure National Park, their agricultural techniques may be more original and serve to preserve a variety of forest species that are important for managing the Isiboro-Secure National Park.

The areas with low level of human population should have only a small influence on primary forests and swidden-fallows may be regenerating naturally. This particular characteristic attracted me to study the Tsimane' fallows during my first visit in 1995. I realized that following the whole cycle of fallow and applying simple methods of vegetation dynamics and identification may reveal how Tsimane' people manage the fallows, maintain soil fertility, and intervene in forest regrowth for assuring vegetation and species diversity. Other factors that make the swidden-fallow study ideal are the Tsimane's knowledge of plants and the small number of non-indigenous trees present. By studying an isolated community within the Isiboro-Secure National Park, I anticipated finding swidden management patterns that would contribute to a deeper understanding of indigenous agriculture in general.

Research Objectives

Current knowledge of fallow management comes from diverse sources, but few are based on rain forests such as the Amazon and most of them are based on an ecological rather than cultural perspective. Among studies on fallowing and its utility, very few make references to the role of culture in relation to fallowing. To my knowledge, no study has been conducted on fallowing techniques and culture among the Tsimane'. I developed several objectives for this study based on preliminary visits and discussions with researchers from several disciplines.

In this study, my aim was to establish how indigenous local resource use influences fallow plot regeneration by describing both cultural and ecological factors involved in fallow plot recovery dynamics of Tsimane' swidden agriculture. I also wanted to explain how indigenous farmers' behavior is related to their experience and knowledge of local resource management. Ultimately, this research was intended to support the local community organization in the Isiboro-Secure National Park and to strengthen the implementation of the Law of Popular Participation through community-based resource management. I specifically:

1. describe Tsimane' fallow system and patterns of vegetation recovery among diverse species;
2. determine the relationship between plant use knowledge and fallow management;
3. document local terminology, specific manipulation techniques, and beliefs related to environmental conservation; and
4. evaluate some physical and chemical properties of soils in fallows.

Review of Literature

Several studies have focused on indigenous swidden agriculture and fallowing and their effects on forest and soil management. The literature reveals many references to swidden fallow vegetation, management, knowledge, nutrient accumulation, and induced changes with forest conversions. The questions regarding indigenous agriculture, length of fallows, and recovery of fallow vegetation are still debated. Some think that swidden does not much affect the vegetation much, while others think that changes in vegetation are irreversible.

In scientific studies of swidden fallows, the majority view is that swidden agriculture is associated with tropical deforestation, soil erosion, endangered biodiversity, and climate change (Fujisaka et al. 1996). However, some scientists believe that there are several benefits associated with swidden fallows. These benefits include improvement of soil structure, organic matter accumulation, and nutrient accumulation in the biomass where trees serve as agents for cycling nutrients. Furthermore, swidden fallows function as weed suppressors, control pests and add diversity of vegetation and habitat. These benefits are associated with management procedures based on indigenous knowledge.

Forest dwellers, once marginalized and ignored, are now recognized by ecologists and developers as sources of information for natural resource management. Increased respect for indigenous people and interest in their values do not obviate the fact that indigenous people have to be considered within the context of a process of worldwide globalization, the historical conditions of different countries, and the existence of a variety of social strata among themselves. People with different socioeconomic and cultural conditions interact differently with forest ecosystems. Such is the case in

Bolivia[2]. Therefore, with regard to indigenous agriculture and its relationship to Amazonian forest, it is necessary to be specific, as has been attempted in this study of the Tsimane' agricultural system.

The argument that indigenous "slash-and-burn" agriculture is a primary cause of "deforestation" must be carefully considered in this context. The practice often signifies destruction of the forest by removing tree cover. However, it has been used to refer to both complete forest conversion and to clearing small plots, as in swidden agriculture. However, the complete conversion of forests has dramatically different ecological consequences than have been demonstrated for swidden agriculture. The definition argued by Angelsen (1995) refers to complete change from forest to agricultural and urban areas. This definition becomes highly politicized as it includes indigenous shifting cultivation and cattle pastures.

The term "deforestation" as used by World Bank does not include forests logged by timber companies, but does include shifting cultivation, even when shifting cultivation is small scale and occurs in secondary forest. However, although both shifting cultivation and logging leave areas to fallow, the quality and size of fallow is fundamentally different. Loggers cut down trees, open roads for newcomers, and the fallow areas are usually huge. In contrast, shifting cultivators usually clear secondary forest and even improve the forest in some cases. I share Angelsen's perspective (1995: 1715) that, at least in the case of Bolivia, "identification of the primary agents of deforestation are not politically neutral". Government agencies and timber companies are only interested in extracting natural resources. From their perspective, indigenous

[2] Tropical forest in Bolivia are occupied by people of different socioeconomic conditions: native

people are an obstacle to attaining this goal, not only because they practice traditional swidden fallow but also simply because they inhabit the areas targeted for the extraction of lumber. In this manner of thinking "traditional keepers" are viewed as an impediment to development programs, globalization, and even to the modern world.

Studies indicate that indigenous people both exploit and manage the forest. For instance, Bora and Runa indigenous peoples, who practice swidden for subsistence production, allow forest regeneration to satisfy their needs (Balée 1994; Hecht et al. 1988; Denevan & Padoch 1987). Their indigenous management system does not show a clear distinction between swidden fallow and forest, but rather a gradual transition that goes from domesticated plants to wild vegetation. The sequence of ecotones from household settlement to the forest shows the intensity of management, which has been described in the Kayapo system as "poles of the continuum" (Posey 1985).

In general, there are diverse indigenous agricultural management systems throughout Southeast Asia, Africa, and tropical America, in which "sacred groves", home gardens, forest gardens, and enriched fallows are the most common (Montagnini & Mendelsohn 1997, Peters & Neuenschwander 1988, Denevan & Padoch, 1987). Among Kayapo Amazonian Indians, there are nine types of management systems in a secondary forest, which illustrate the diverse and complex kinds of natural resource management found in the indigenous system (Posey 1985). Therefore, the discussion of indigenous management related to swidden fallow production must be considered in a context of specific culture, time, and space.

Amazonian people, relocalized miners, highlander Indians, cattle rangers, foreign colonizers and so on.

Attempts to understand indigenous management systems have led scholars to classify them worldwide. Wiersum (1997) distinguishes four types of management among native people: (1) Protected forests with religious significance (2) Enriched old-growth forest by selective protection (3) Reconstructed native forest, semi-cultivated forest with planted species, and encouraged wild species, and (4) Mixed arboriculture, often with domesticated tree species. Despite diverse approaches, the key to studying indigenous management is its integrated nature, especially in swidden cultivation (Garzón & Macuritofe 1990, Posey 1985).

As indicated earlier, the local community perspective and values differ from those of environmentalists and conservationists. Community forest management may not respond to concerns about global warming or deforestation, and may not even be recognized as a specialized activity. However, management is present in every indigenous activity and is part of daily life. Resource management is a basis of survival and security for the family, community, and the surrounding forest environment.

The swidden agricultural system is a constant dynamic between agriculture and forestry, rather than merely being a type of agroforestry. Literature reveals that swidden cultivation not only enhances the natural recovery of forests after human disturbance, but also balances the interaction between humans and the protectors of natural resources (Wiersum 1997, Vickers 1983, Flowers et al. 1982). Therefore, indigenous management systems appear to accomplish several functions for the people and the community such as economic satisfaction, control of weed and pests, fertility recuperation, and reproduction of culture.

It has been reported that fallowing land after a cropping period has an economic and ecological function. Management of secondary vegetation involves many factors such as individual needs, cultural preferences, and the appearance of spontaneous tree species that produce food and other useful products (Irvine 1989). Species found in fallow are purposely planted or protected. For instance, Indonesian farmers in west Kalimantan manage large fallows for subsistence (De Jong 1997). Swidden fallow management begins at the time of forest clearing and burning when valuable species like palms and some trees are left untouched. During and after cropping, plots are enriched by perennial species, such as pineapple, plantain, and other larger trees planted among annuals (Unruh 1990). This general pattern of fallow management is relevant to fallow ecology because activities directed to the production of forest crops influence vegetation dynamics for the immediate fallow succession. Thus, there is an interplay between managed plants and succession vegetation, which not only increases the presence of economic species that benefit the community (Denevan & Padoch 1987) but also subsistence species in communities with no market relations.

Conklin's (1961, 1969) classic definition of shifting consists of clearing and cropping for a short period which is then followed by fallowing for several years. Since Conklin completed his work, ecological concepts and knowledge about cultivation derived from Conklin's study (1957) among the Hanunoo have been enriched with studies of other tropical areas. Many terms exist to designate indigenous tropical agriculture, such as shifting cultivation (Hecht 1982), "slash-and-burn" agriculture (Uhl et al. 1989), and gardens (Descola 1994), to mention a few. Similarly, there are specific terms that refer to fallows: **kaingin** (Philippine), **ladang** (Indonesia), **taungya** (Burma),

jhum (India), **milpa** (Mexico) and **conuco** (Venezuela). Fallowing in concept and practice is widespread among people in tropical countries, including Amazonian Indians (Conklin 1969, Denevan & Padoch 1987).

Before Conklin's research, this system of cultivation was criticized by national governments and development organizations (Thurston 1997). However, later studies demonstrated many examples of adequate management and many people worldwide make a living from swidden agriculture in the tropics (Kleinman et al. 1995). Considering the diverse cultures involved it is evident that there is a great diversity in swidden agriculture at many levels given the diversity of tropical ecosystems and the degrees of cultural integration of its practitioners.

Several authors have attempted to classify swidden agriculture. From an agronomic perspective Greenland (1973) identified four phases of shifting agriculture associated with fertility restoration. To this author shifting cultivation "is an essential response to the problem of obtaining food where the soil itself is incapable of sustaining the continuous production of crops for an unlimited period" (Greenland 1973, 5). On the other hand, Boserup (1965), using population density in her model, argues that fallows will be replaced by multicropping. Raintree & Warner (1986) attempt to classify fallow on the criteria of economic integration, land use, and labor intensity that hopes to absorb the indigenous system. These authors unanimously view indigenous tropical agriculture under evolutionary categories of classification, and they expect that shifting agriculture will eventually be replaced by a more productive and modern system. Thus the diversity of existent systems will disappear and homogenization will begin.

In contrast, studies in other tropical areas show the persistence and diversification of swidden agriculture in spite of the process of integration. Ramakrishnan (1992) considered Asian tribal communities of differing linguistic groups, geographical conditions, and underlying sociocultural factors and found great variation in land use as well as in swidden practice. Therefore, it is important to recognize the variety of indigenous agricultural systems that exist rather than generalize about a general system of indigenous swidden cultivation. This variety of swidden agricultural systems led Fujisaka et al. (1996) to conduct swidden classification research utilizing four variables: type of initial vegetative cover, type of resource users, type of final vegetative cover remaining, and length of fallow plot. Of the 136 studies reviewed, use of secondary forest, indigenous communities and natural regeneration represented 45 cases (33%) (Fujisaka et al. 1996).

In Amazonian countries, as in other tropical countries, indigenous farming consists of a large variety of swidden cultivation systems that reflect different ecosystem adaptations, degrees of detribalization, and sociocultural levels of adaptation. The swidden system developed in the humid tropics and its diversification on the eastern flank of the Andes is fairly consistent with this perspective. After two or three years of cropping, a plot declines in soil fertility and vegetation invasion begins, after which the plots are then left for a long period of swidden fallow. During this period, indigenous people tend to enrich plots by planting productive trees (Harris 1971, Posey 1985, Stocks 1983, Denevan et al. 1984).

Within tropical agricultural studies, including those of indigenous agriculture, weeds are viewed as the most serious salient problem. It is well documented that weeds constitute a limiting factor leading to the “abandonment” of land. Therefore, from a scientific view, fallows are a farmer’s strategy to confront weeds, because by shifting fields and leaving lands to fallow they can control weeds, disease, and maintain soil fertility (Rouw 1995). However, inelastic definitions of weeds are problematic and are changing. In some current studies, weeds are seen as contributing to agroecosystems. For instance, people in Tabasco, Mexico, conserved and encouraged certain weeds. In India, the jhum system conserved 20% of the total weeds in cropping plots (Ramakrishnan 1992). Fallowing, as a weed management strategy not only marks the transition from a main cropping period to natural or managed plant succession, but also evidences that weeds rehabilitate the land for the next cycle of cropping. The success of fallows for improving soil conditions may rely on several factors. According to Kleinman et al. (1995), these include degree of soil degradation, characteristics of vegetation regrowth, time left for fallowing, and the type of plants that are introduced and managed as part of the fallowed fields.

Fallow-based agricultural production is also criticized for shortening the fallow, which may degrade forest structure by converting the pristine forest into grass and shrublands. But studies show that swidden agriculture is highly adapted to low soil fertility and persistent weeds, in which fallowing has the role of problem solver (De Jong 1997). Further, in spite of the negative aspects of fallowing, it is contended that only fallow technology maintains soil productivity by natural processes, while shortening the fallow and lengthening the period of production depletes the soil (Montagnini & Mendelsohn 1997). In addition, recent studies show that understory vegetation has a higher leaf nutrient content than leaves of overstory trees. Young vegetative material was higher in nitrogen and potassium levels than older leaves and has a quick growing cycle that enriches the soil more rapidly than later successional stands (Unruh 1990). Unruh's study is critical for understanding that industrial inputs (fertilizer and herbicides) are not the only options when soil restoration is needed, but that labor intensity and agroforestry are also valuable (Raintree & Warner, 1986).

Traditional agricultural practices, with short cropping and long fallows, are considered a relatively benign disturbance that does not threaten ecosystem functions. Those practices include shade trees, mixed cropping species that differ in phenology, dense spacing of crops, and fallowing to preserve organic soil matter. Species richness is assumed to confer pest protection and decrease crop failure (Dufour 1990). However, forest regeneration is the main factor in the sustainability of swidden systems. Studies on indigenous management show that selective weeding, protecting plants, and planting have greater impacts on species diversity that cannot be achieved regarding height and biomass and are faster than natural regeneration, especially in home gardens (Uhl 1987, 1983). Therefore, recovery of abandoned fallow, in terms of biomass and species diversity, is expected to increase (Saldarriga et al. 1988). This seems to be variable and may rely on climate, types of indigenous management, and the availability of seeds. Optimistically we can expect human settlements to be surrounded by a complexity of swidden agriculture, agroforestry gardens, and forest regeneration at various stages in which fallows may have many attributes during succession (Ramakrishnan 1992).

Although there are many types of shifting cultivation, the general pattern of this agricultural system is the alternation of short period of cropping and long period of fallows as a means of management. This model may be considered the classic type:

forest areas are cleared, burned, and planted with a variety of crops that imitate in structure and function the forest ecosystem. My research focuses not only on current Tsimane’ agricultural practices and their historical origin, but also on the implications of indigenous knowledge for the organization of daily life and its relation to natural resource management. While the term agriculture presupposes the use of land and soil, tropical indigenous cultivators depend less on soil than on vegetation management. In fact, Geertz (1963) states that swidden agriculture relies on “plant-to-plant” interaction.

Indigenous knowledge in a context of environmental degradation has a utilitarian value for industrial countries (Brush 1993). Recent interest in the transformation of shifting cultivation arises from the fact that many swidden systems, previously existing in ecological balance with their environment, are now breaking down (Raintree & Warner 1986). However, swidden and fallows provide the best example of sustainable use of tropical rainforest under low population densities. The most recently studied is management of swidden fallows, in which annual crops are combined with perennial tree crops and the natural processes of regeneration. The result of the agricultural practices shows the forest in a form of vegetation patches in different stages of succession and under differing degrees of management. These fallows are used for food, medicinal, materials, as well as for hunting game animals (Dufour 1990).

CHAPTER 3
STUDY DESIGN AND METHODOLOGICAL PROCEDURES

Theoretical Assumptions

The Tsimane' say that they have practiced swidden agriculture from *uracyas* (ancient times). This study determines whether the Tsimane', the least culturally integrated group of the study area, practice local swidden fallow in terms of indigenous management practices. This includes farmer decisions that may degrade, maintain or enrich the local forest ecosystem.

Whether or not the interplay of indigenous knowledge and swidden subsistence production provides the basis of resource management, this study addresses how knowledge and behavior function as an integrated system of daily life and agricultural ecosystem management. The following general hypotheses address this issue.

A. If an indigenous swidden cultivation system results in adequate ecosystem management over time, then the Tsimane' people deliberately manipulate the fallow vegetation for ecological purposes as well as for production purposes.

B. If this is true, indigenous knowledge and behavior, as part of a cultural system, should be comprised of an underlying plan of local resource management and thus ecosystem conservation through vegetation regeneration that can be extended to National Park initiatives.

Specific assumptions derived from the general hypothetical statements are as follows:

- Tsimane' forest clearance will affect vegetation regeneration depending on the size, shape, techniques of clearance, and purposes of land use as well as on proximity to the communities and fallow age. Recent swidden fallows have more cultivated subsistence crops, less area under vegetation production and more plants to provide for household needs.
- Regeneration throughout the period of fallow management will increase plant diversity, which might be significant in the amount of management practiced either for subsistence purposes or household needs.
- Managed fallows, depending on age, will improve soil fertility.
- Types of soil knowledge will be associated with specific plants related to subsistence production, plant regrowth and fertilization.
- Fallow management practices are closely associated with indigenous knowledge and cultural perceptions that dictate a specific relationship between humans and nature.

Methodological Procedures

The main objective of the research project was to study swidden fallows in a Tsimane' indigenous settlement, Asunta in the Subcentral del Territorio Indígena Nacional del Parque Isiboro-Secure (TIPNIS). To this purpose, a systematic approach was designed to test both theoretical and methodological frameworks. Participatory research methodology was employed from an interdisciplinary perspective. Concepts derived from cultural anthropology and ecology were combined considering both social knowledge and environmental processes. Techniques included participant-observation, structured interviews and ecological sampling. These techniques included collecting qualitative and quantitative data.

The study area's status as a National Park and the extensive travel required within the Park necessitated coordination with local indigenous organizations and national institutions. TIPNIS approved the research and supported me by assisting with the logistics of communication and the relationship with the community throughout the research period. I traveled to the site via small aircraft and brought materials for research and living items that were counted every three months for about a one-year period.

I soon realized that my ambitious fieldwork design was not totally achievable due to funding and transportation limitations. This forced me to reformulate my field research strategy to use more functional methods and an optimal timetable. Ethnographic and ecological methods were thus revised to conduct field research. The fieldwork was limited to main aspects of fallow management and its knowledge. The study considers characteristics of vegetation regeneration, fallow management, knowledge of plants used, and cultural aspects of Tsimane' swidden cultivation. I obtained data by assessing human actions in a cultural context and by recording physical characteristics of the local environment.

Before beginning the fieldwork in 1997, I had the good fortune to participate in a survey throughout the Isiboro-Secure National Park, which gave me an opportunity to become familiar with the Indigenous Territorry (TIPNIS) communities. This acquainted me with the park and served as important background for studying the community of Asunta. While living in Asunta, I participated in community life and learned the local language. This was necessary to develop a local cultural understanding in order to elicit, document, and sample information correctly.

The first intensive fieldwork in Asunta was conducted during the fall of 1997, from August to November, with the assistance of the Tsimane' people. It provided me with a geographical and cultural awareness of fallow areas and their distribution. The distribution of plots and human interference varied in respect to physiographic properties and transportation facilities such as vegetation cover and rivers. Natural primary forest and secondary vegetation were mapped and described. Data collected was based on permanent resident information by visiting their field during the working days.

Visiting cropping plots and fallows of different ages were the main task regarding management and required the identification and description of family fallows. Revisiting the plots several times allowed me to map and observe vegetation regrowth and peoples' behavior at different stages. This provided me with the knowledge of plants used by the Tsimane' people and an understanding of the wisdom of swidden agriculture.

I identified and coded fallow plots with plot owners who described vegetation and provided cropping history. I estimated the number of plots owned by the family head and their distribution. Locating fallows provided information regarding earlier settlements. This aided in sampling transects and soils in the plots. Once I had a general knowledge of fallows, community structure and the local language, I began to elicit information on fallow plant names and management practices.

I returned to the field during the dry season of 1998 to sample fallow plots and inventory plants. I used the transect method to inventory plant population in fallow plots. Transects were conducted by walking across plots with their owners in a diagonal direction. This was repeated twice. Plants within one meter of each transect were counted and recorded in three categories: (1) less than 20cm; (2) from 20cm to 150cm; and (3) above 150cm. This provided a general inventory of plant population frequency, abundance and height at different ages of fallow.

Some ethnobotany techniques were also employed with the assistance of the Herbario Nacional de Bolivia. Vegetation recorded from transects were sorted and organized to collect leaves and, where possible, flowers and fruits. Collected materials were pressed, dried, and sent to the laboratory for species identification. In the field, only local names were used for coding and recording plant names in 24 plots. Household heads served as guides for collecting leaves in their own plots.

To evaluate the physical and chemical properties of soil, 12 plots were chosen from 72 fallow plots at different ages and areas. In selected plots 6 samples were taken from the surface to 15cm depth. The samples were homogenized and 2 composite samples of 1 kg each were taken for laboratory analysis. The samples were coded, dried at room temperature, packed in paper and then plastic bags. Samples collected were also sent to the Universidad Mayor de San Andrés in La Paz for chemical identification and textural analysis.

Plant use knowledge research was carried out at different times of night for each household. Materials from plot interviews and transects were systematically organized and prepared for eliciting plant knowledge and use of plants in the community.

Structured interviews were applied for all the plants found in transects regarding community usage and plant vegetation characteristics. These interviews were conducted by three Tsimane' consultants to clarify details mentioned by the owners of the fallow and attain deep knowledge of plants to compare with other interviews. Data collected under the whole procedure included ecosystem description, vegetation regeneration, soil knowledge and soil physical and chemical properties, and cultural correlates in managing fallows.

CHAPTER 4
BACKGROUND TO THE STUDY

The Isiboro- Secure National Park Ecosystems and Sociocultural Context

The Amazon basin is a complex forest ecosystem, rich in biodiversity but fragile if not managed adequately (Uhl 1983; Sponsel 1986). This ecosystem presently is subject to rapid change due to industrial forestry, colonist migration, and agricultural use of land (Bierregaard et al. 1992; Stone 1992). In Bolivia, as in other Amazonian countries, local indigenous and non-indigenous populations rely on forest resources in which economic activities are diverse. Indigenous people engage solely in swidden agriculture, while some non-indigenous people attempt to optimize forest and savanna according to natural ecosystems. Others transform ecosystems for agricultural industries and cattle ranching. Further, the land use pattern in the Bolivian Amazon varies according to the economic and cultural backgrounds of the communities (Jones 1990, Denevan 1966).

Since swidden agriculture is the most common form of land use among the Amazonian indigenous people of Bolivia (including those located in the Isiboro-Secure National Park), and given the lack of information on this issue, the need for studies on indigenous agricultural systems both for public policy implementation and for assisting Indigenous Organizations is apparent. The management of indigenous territory begins with understanding indigenous regional agricultural systems and other forms of resource use in the communities. As the indigenous territory has dual status (as a National Park and Indigenous Territory), the indigenous organization is responsible for conserving and developing the area. As communities change their production to become more interactive with local market systems, a database may be useful for resource management. The activities generated by new production modalities, such as cattle and hog production, will affect the use of natural resources. This may distort the native land use system and traditional linkages among the communities and the natural ecosystem.

Closely related to swidden agriculture is animal husbandry, which produces cash income and animal protein. Cattle and pigs were introduced in colonial times, and today rangeland within the park belong to indigenous and non-indigenous people. Animal husbandry is reinforced by the new modalities of production. In communities without natural pasture, this could negatively impact forest resources on a large scale due to conversion of forest to pasture.

The local level problems outlined above require a holistic approach for understanding the dynamics of the Isiboro-Secure National Park ecosystem as well as the function of traditional communities as part of the tropical forest and of the savanna-flooding ecosystem. Previous studies consider either the whole agricultural cycle or the vegetative system but have not included specifically how swidden fallow management relates to culture and knowledge. Thus, the significance of this study is its holistic focus on one indigenous community and on its system of swidden-fallow management.

Until recently, indigenous swidden agricultural systems functioned as autarchical systems. This is still the case in isolated areas. However, these self-sufficient systems have become more and more articulated to national and regional markets through the introduction of modern technology, lumber industries, and trade interactions. Given these changes, knowledge of the local community swidden agricultural ecosystem in the National Park indigenous territory will contribute to an assessment of indigenous resource use as both a public resource and as a common resource that has to be protected and shared respectively by several communities with different cultural origins.

Traditional communities tend to act on the basis of local knowledge, traditional rights and cultural beliefs regarding local resource use. They may not understand how natural resources function in a scientific way, but they contribute to resource conservation and are an important source of management in their use of cultural codes and human energy. Additionally, these societies have the advantage of having adapted to forest environments. Thus, they are capable of adjusting to other natural phenomena and socio-economic factors introduced from the outside. Given their habitual human-nature interactions, indigenous people are in a position to assess the potential impact of development initiatives on forest and savanna ecosystems.

Sharing Common Resources Among Different Cultural Groups

The existing indigenous populations that inhabit the Indigenous Territory National Park (TIPNIS) come from diverse social, cultural and linguistic backgrounds. According the census of 1993, TIPNIS has 47 communities with 4,563 inhabitants from the following groups: 54% are Mojeño-Trinitarios, 25% are Yuracare, and 5% are Tsimane' (INE/ONU 1993). The territory is characterized by marked anthropogenic differences within the Park, which consist of earth mound constructions in seasonally flooded areas, river shore management, savanna pasture areas, and foothill forest activities. Ecological and cultural diversity in the park has to be considered before imposing models of conservation and experimenting with modalities of production. Park management and local community demands must be balanced to avoid difficulties with indigenous organizations. Historically, these communities lived and ranged with some sense of territoriality in the main Park area. In doing so, they developed regulations for sharing forest resources in a complementary manner, fostering mutual respect among the communities.

This section briefly evaluates the relationship between different cultural groups, their ecosystems, and subsistence strategies. From an interdisciplinary perspective, this chapter will depict the current livelihood of three cultural groups: Mojeño-Trinitario, Yuracares and Tsimane'. It includes agricultural and animal husbandry practices, the relationship between their land use systems and the forest, and self-subsistence strategies in the communities.

The TIPNIS, which is concerned with daily community activities and effective administration, is divided into three main areas based on permanent rivers: the Isiboro, the Ichoa and the Secure. These rivers enter the park from the Andean foothills and meet at a point in the savanna area, where the administrative center, known as the Centro de Gestión is located (70.5 km from Puerto Barador-Trinidad and between 15° 34' 50"s and 65° 08' 42"w). From this point, the area between the Isiboro and Secure Rivers to the Andean hills is designated the Indigenous Territory National Park (See Fig. 1.1). The total area consolidated is about 1.200.000 ha with altitudes ranging from 170 to 3000m in mountainous areas. The climatic characteristics within the park also vary. The average mean annual temperature is 15-20 C°. Precipitation ranges from 6000 mm in the mountains to 1600 mm in the savanna areas. Ecoclimatic zones include “llanura” humid forest, high altitude and inundated forest, montano humid forest, and humid savanna (Lehm 1996).

The first of the three areas, to the south of Centro de Gestión is the Isiboro River area, a natural boundary to the National Park’s south (See map below). There are several Yuracare communities at the base of the river, and in the foothills of the mountains, both Yuracare and Mojeño-Trinitario communities coexist. The communities of this area are close to Cochabamba, and indigenous people from this area are in contact with Andean colonists.

Map

The second area is identified with the Ichoa River that runs through the middle of the park. Upstream from where it meets the Isiboro River, Mojeño-Trinitario community settlements and some Yuracare families coexist. Some of these communities are located in heavily seasonally flooded areas and, during floods, the people take advantage of the high earth mound in the area. Other communities, mostly Trinitarios, are located at the foothills and also interact with colonizers, as previously mentioned. The third area is by the Secure River, located to the north of the Park. Human settlements are scattered throughout the area from the Centro de Gestion to the Andean foothills. Several communities of Yuracares, Mojeños-Trinitarios, and Tsimane's live relatively close to each other and share common resources on the riverbanks.

These three cultural groups are settled sparsely along the riverside at different altitudes, ranging from 150 to 500m above sea level. All the communities considered here practice swidden agriculture. Their economies vary based on socio-cultural backgrounds and agricultural orientation. Mojeño-Trinitarios, who are more acculturated to cash economy and urban living, tend to cultivate larger areas than other groups. Their agricultural activities are more mono-mixed and organized, and they usually do not shift agricultural plots. Yuracares may have cacao plantations and/or practice swidden agriculture, depending upon where they are settled. Most of the Yuracare families cultivate a half-hectare each year, but some cultivate less than a half-hectare and shift agricultural plots. Tsimane's also practice swidden agriculture for their subsistence, but are less integrated into the market. Tsimane' swidden cultivation involves polycropping and they tend to cultivate small patches. The cropping system in all of the communities emphasizes rice, manioc and maize, and plantation crops such as cacao and citrus.

Additionally, every group cultivates some ethnically preferred but little-known crops. All of these groups practice short-cycle fallow agricultural plots ranging in age from 3 to 30 years, and they tend to plant useful trees where fallows are considered appropriate.

Regarding animal husbandry, communities located in the savanna areas with natural pastures, such as of those the Mojeños-Trinitarios and Yuracares, tend to raise some cattle, whereas Tsimane's, because of their traditions and their restriction to the foothill areas, do not have any cattle. Communities with natural savanna areas enjoy a low-cost way to maintain cattle, which provides meat, cash income, and transportation advantages. Other animals found among all the communities include pigs and chickens, which are valued because they are easily transported to the market in small canoes to generate cash income and also serve for household consumption. Recycling animal residuals for agricultural fallows is not practiced here as it is in many other agricultural societies.

The Yuracare and Tsimane' raise pigs and chickens principally for selling or exchanging with traders. In contrast, the Mojeño-Trinitarios both consume and sell these animals in Trinidad, the capital of the department of Beni, where these animals are in demand. The Tsimane' animal-raising system does not resemble domesticated animal management because they do not provide food or build any animal habitats. In contrast, the Mojeño- Trinitario feed their livestock, albeit with poor quality grains, tubers, and waste products of plantains, corn, and rice.

Tsimane' and Yuracare communities depend much more on wild resources than Mojeño-Trinitarios. Indeed, food energy and protein consumption from agriculture is relatively high for the Mojeño-Trinitario, as is animal protein consumption from animal husbandry. In turn, the Tsimane' and Yuracare have a more diversified food base: they fish, hunt, gather, and cultivate their food. All the communities are highly dependent on the forest for swidden agriculture, fodder, fuelwood, and food from the wild. Both groups will be directly affected if natural forest resources decline.

The indigenous territories still have large forest and savanna resources in the Isiboro-Secure National Park in which community activities are centered. Cattle provide cash income in floodlands, while forests provide for a wide variety of economic activities. Historic and sociocultural patterns also vary widely among communities. This rich variety is important for the future of the Isiboro-Secure National Park and the communities where increasing population pressure and replications of development practices may affect the whole ecosystem. Indigenous technicians and supporting non governmental organizations (NGOs) must consider the ecological and socioeconomic impacts of swidden-related agroforestry, animal husbandry and other traditional practices. For example, plants transferred from forests to house gardens and improvement of lesser-known plants for food may become critically important for the local economy. Any introduction of other systems and animals should include a careful evaluation of the potential ecological, social, and economic impacts.

In sum, the Isiboro-Secure National Park is set in a complex neotropical ecosystem in the Bolivian Amazon. This complexity of the natural ecosystem is coupled with complex cultures, languages and human organizations. Indigenous people primarily depend on swidden agriculture, but they also take advantage of natural products according to their ecosystem and cultural preferences. The complexity and variation rely on climate and physiogeography that determine the quantity and quality of existing flora and fauna. This context of the Asunta community must be taken into account for a human-ecological understanding.

Tsimane' Population

The Tsimane's are an ethnic group with about 5,695 inhabitants spread out over a area of 401,322,8054 ha in the Maniqui River area (CIRTB 1996). Swidden subsistence agriculture is the main household economic activity in all territories, with small differences regarding size, types of crop cultivated, and the use of technology. The population largely lives along the Maniqui River that runs from the Patsene Mountain to northern savanna areas (PNUD-SAE 1994). Traditionally, their ranging area was the large zone of eastern Andean foothills in the Amazonian forest (Armentia 1905). Today, although most of the Tsimane' communities are settled in the Maniqui River area (61 communities), there are at least three more areas where the Tsimane' live: Pilon Lajas (25 communities), Multiétnico (5 settlements) and the Isiboro-Secure National Park (3 communities). The population density for the department of Beni is lower (1.5 inhabitants per square km) compared to national areas (6.9 inhabitants per square km) but equal to their counterparts (INE 1996). The population is presently increasing faster than in past decades. This trend is similar to the rest of the detribalized societies in Bolivia and may have an adverse impact on the future of natural resources.

The Tsimane' are linguistically and culturally closely related to the Moseten ethnic group. Tsimane' and Moseten speak two dialects of the same language and are part of the macro-pano linguistic group (Ritchie 1979). In the past, there was much closer interaction with the Moseten of Covendo. Today, because of distance and acculturation factors such as market integration and transportation facilities, they barely communicate. Tsimane', an indigenous people, once lived under a peonage system for manufacturing *cajtafa* palm leaves and were excluded from urban areas. At the present time the Tsimane' interact frequently with local authorities, loggers, colonists, and traders in urban areas.

Tsimane' Community Organization

The Tsimane' live in small, extended nuclear families in which patriarchal kinship binds husbands' and wives' families. Generally, a newly married couple adopts matrilocal residence for a few years, and then the new family establishes a place to live near the husband's parents' house in the community. There are still some sororal marriages practiced among the Tsimane'. In the community where I stayed, two families lived this way. However, this pattern is changing with the impact of missionaries and frequent visits from outsiders. Tsimane' settlements are characterized by both dispersed households and concentrated small communities in dynamic patterns. The number of families per settlement ranges from 15 to 30. There is no centralized political structure in the communities, though a recently created supra-organization designates community representatives as chiefs who interact with outsiders. This supra-organization, called Gran Consejo Tsimane' was created due to pressure on natural resources generated by loggers and traders in 1990s. It represents all Tsimane' communities except three that are settled along the Secure River and represented by the TIPNIS organization.

As with other forest dwellers, Tsimane' communities are less articulated into the national society and receive little or no health and educational services. Although some private missionary schools serve Tsimane' communities, they do not reach all 120 communities (Mihotek 1994). Most Tsimane' people are monolingual, except for the rural teachers and a group of leaders who live mostly in the urban areas. Most school children and persons related to loggers and traders are becoming bilingual and acculturated.

The Study Area and Physical Characterization

I conducted my fieldwork in Asunta, the most isolated of three National Park communities. This community is settled along the upper extreme of the Secure River, where 25 Tsimane' families have lived since the 1950s. They maintain relationships with other Tsimane' but feel that they are structurally more linked to the Subcentral TIPNIS organization. Indeed, the Municipality of San Ignacio designates the local Asunta authority, the Corregidor, through TIPNIS. However, unlike other communities in the Isiboro-Secure National Park, in Asunta there is no **cabildo** (government house).

The Asunta community is located on the extreme southwest shore of the Secure River, approximately 186 km directly southwest from Trinidad in the Beni department of Bolivia. The extension of the community is between 66° 25' 44" longitude west and 15° 49' 59" latitude south in Moxos province. It is located in the open valleys of the Marimono Mountains at 258m with Amazonian flatlands to the east and the Andean Mountains to the west (See Fig. 3. 1). This isolated location contributed to the community's low adoption of conventional Bolivian lifestyles and swidden agricultural practices.

Asunta's ranging area covers approximately eight percent of the geographical area of the Indigenous Territory in the Isiboro-Secure National Park and includes the main Park area under forest. Nevertheless, recent studies suggest that only ten percent of the total Asunta Territory is forested. Adjacent to the Isiboro-Secure National Park lay the buffer zones, much of which were previously classified as forest. This area of Asunta territory was recently selectively deforested by logging companies. In addition, the mountains surrounding Asunta, though classified as evergreen forest, may no longer have forest qualities. The Indigenous Territory is collectively owned by the communities under a communal property rights regime. However, the Isiboro-Secure National Park area is also considered State property, which implies that the national government has a right to exploit the park's natural resources such as petroleum. Further, within the park, some mestizo private landholders raise cattle. This mixture of rights and degrees of tenancy makes indigenous management of their territory difficult and complicated.

Each community operates according to a common resource use right, which usually fits into the "*uti possidetis*" right (the territory under control and things attached to it belong to the possessor). For example, a residence, once established, remains permanent unless there are deaths or accusations of sorcery. In this situation, the residence may be relocated. Family and community activities extend over a radius of 16 km around Asunta.

Land not only implies vegetation or physical features, but also cultural significance. For instance, community members still visit springs, where they used to obtain salt in the past, not for extracting the mineral but for hunting animals. Animals, like humans, consume minerals, and these springs have been imbued with ritual significance (Daillant 1998). One spring containing petroleum is very well known, and is occasionally used for fuel or medicinal purposes. Likewise, land, mountains and forest have cultural significance because they are identified in myths about the origin of humans and forest animals.

The vegetation of the area fits within the “Amazonian forest” classification having an altitude of 100 to 250m (Killeen et al. 1993). It is classified as a humid tropical forest (Holdridge 1975). However, the hilly areas might belong to the “montaña” classification, where altitude reaches 1500m. This forest may be the most complex in the world, containing 100 species per hectare. The vegetation presents four strata in which the tallest trees reach 55m in height called mapajo, almendrillo, verdolago, and ochoo; the co-dominant species grow up to 43m in height; trees with thinner trunks grow to 15 to 28m in height; and the sotoforest, which is less dense but with bushes, has many other smaller trees (Holdridge 1975). The forest is similar to Pilon Lajas (another Tsimane’ surrounding area) in which the lower canopy reaches 30m and the upper grows up to 45m (Piland 1976). The local rain forest vegetation typically has primary and secondary swidden fallow forest vegetation, in which there are a variety of trees, shrubs, and lianas. Weeds are not common, although in some agricultural plots they appear in small patches, disappearing during the first two or three years of fallow.

Selective timber extraction has been carried out in the buffer zones of the Asunta community during the last five years. Indeed, three mahogany companies (SIRIMA, Monte Verde and San Ambrosio) hired local people to find and fell trees to meet Brazilian and national market demands. Most of the trunks felled have been abandoned and still remain in the area due to indigenous organization resistance. Falling trees further destroyed vegetation, but the natural environment rapidly replenishes these damages. The major vegetational damage came from the precarious roads opened to transport logs. These roads require tree removal and a stable terrain, which sometimes involves removing rocks.

In addition to damaging the vegetation and soil, road builders do not respect sacred places. For example, in 1996, because of their ignorance of local culture, the SIRIMA logging company opened roads where Tsimane' cultural remains were located. To reach the Asunta area, the company destroyed a Tsimane' petrograph, the only known cosmology artifact in Tsimane' culture (Daillant 1998). Another disturbance occurred in 1998, when a petroleum company (REPSOL) explored and felled forest patches for a helicopter landing and transects. The disturbance affected the vegetation, game, and people. Noise from the explosions annoyed the Tsimane' people and frightened wild animals.

Fuel consumed in households comes from swidden fields. When it is scarce, during the dry season (July to September), people seek dried wood from the riverbanks. Thus, domestic utilization of fuelwood does not disturb primary forest. The *cajtafa* palm is harvested for domestic uses and cash income. Apparently, this harvesting does not have a severe negative impact on this species, since the palms are managed and quickly regenerate. In fact, *cajtafa* can be re-harvested within one year of past harvesting. Swidden agriculture, sometimes identified as forest farming, also appears not to be a relevant factor in forest degradation in the area of Asunta. The area cleared under swidden cultivation is about 4ha annually for whole community. Estimations on the use of forest in Asunta may be useful for park management.

Climate and Soils Characteristics

Climate varies from the lower elevation savanna area to a mountainous rainforest in the hilly areas. The temperature and rainfall patterns of San Borja, illustrated in Fig. 3.2, Fig. 3.3 and Fig. 3.4, are similar to patterns in the Asunta area. At lower elevations, there are two meteorological stations, San Borja at 193m and Trinidad at 155m, which approximately indicate the current climatic regional pattern for the savanna and foothill locations. Much of the annual rainfall occurs from January to March. The regional average annual rainfall is about 2500 mm in the area of San Borja and Asunta, and ranged from 500 mm to 2850 mm during the first year of this study. Winter extends from May to July with frequent rains and strong winds. August to September encompasses the dry season, also accompanied by winds.

Figure 3.2 Monthly Precipitations in the Area (1997)

The maximum and minimum temperatures are 27° C and 21° C during the rainy

and summer seasons, re

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forest activities.

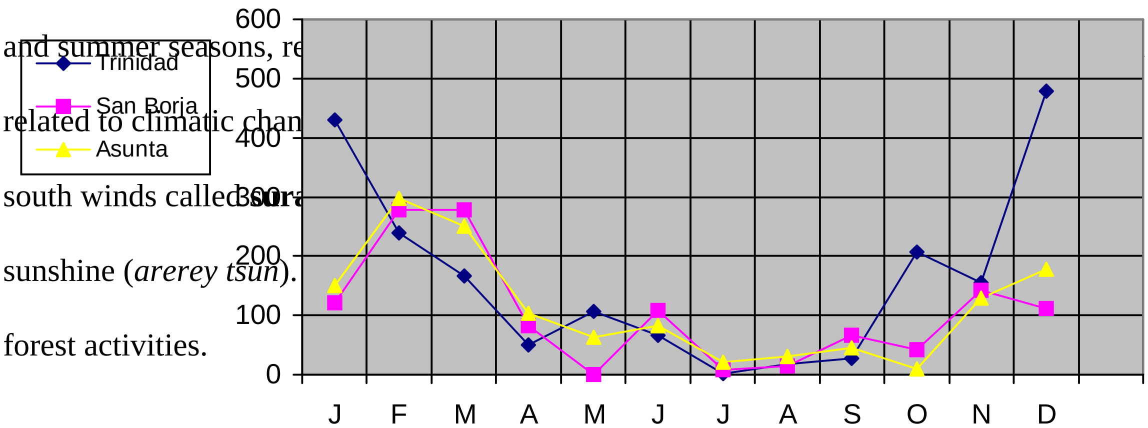


Figure 3.3 Annual Temperature in the Area (1997)

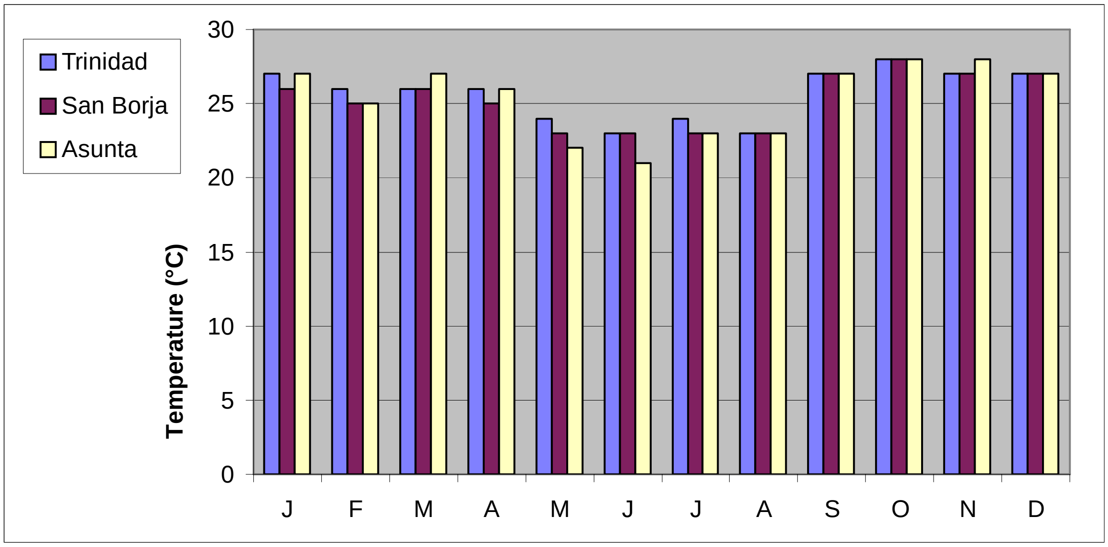
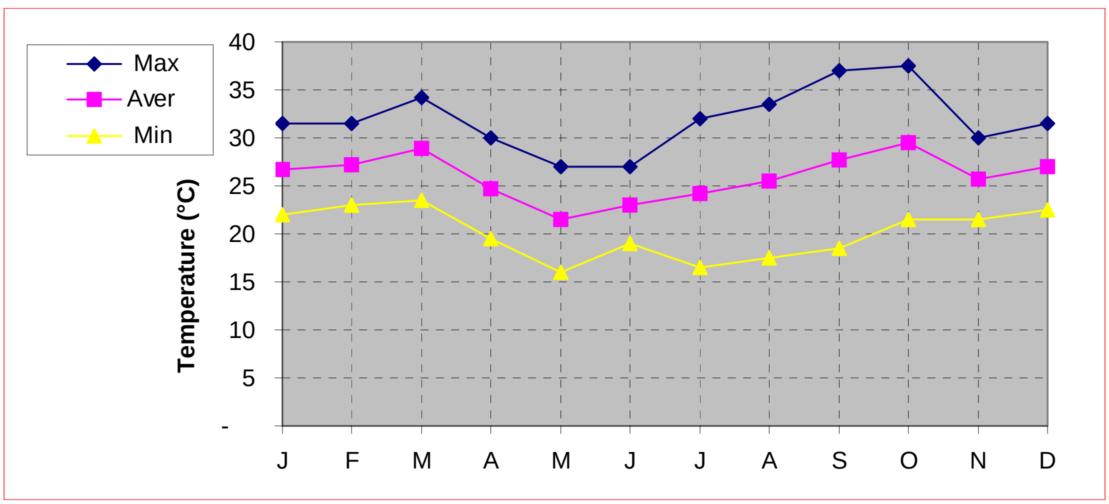


Figure 3.4 Asunta Annual Temperature (1997)



Geophysical factors also determine land use and decision-making in swidden agricultural systems. The natural topography of soils from Oromomo to the mountains of Eva Eva are generally surrounded by smooth hills and irrigated by temporary and permanent rivers. Studies on soils show that Amazonian soils are diverse, with acidity and rapid depletion of nutrients as their main problems (Dickenson 1987). Nutrients are not held in the soil, but in the tree biomass, which is recycled constantly (Prance 1990). The soils may correspond to alluvial types, mixed with gravel, sand, and lime. The soils are superficial with low pH and P. The area is not recommended for agriculture or cattle pasture, but rather for continual production of trees (Holdridge 1975).

Asunta Community Formation

Community formation at Asunta and the resulting forest disturbance in the area date back to 50 years ago. One elderly community member recalled that around 1950, because of the scarcity of game and fishing in the area of Maniqui, some people decided to go up to the Maniqui River in their small canoes to the Cuchisama area. Trini Cari, one of the travelers and other four *Chatedye* (Juan, Pedro, Ventura and Fermin) stayed for a while in Cuchisama, but were not satisfied with the resources they found. While these first migrants were still exploring, they reached the headwaters of the Secure River, behind the Eva Eva mountain on the San Borja side, where they established their houses near the confluence of the Isinuta, Toñas and Ushve Rivers and began to clear forest for subsistence. The earlier swidden plots are scattered around these locations. At that time, Trini, the eldest, would occasionally travel across the Marimono Mountains to visit their Mosetenes counterparts. He remembers that the round-trip used to take two weeks.

Then, a second wave of migrants came to the Asunta area. Julio Cari, along with Native Cari, Luis Chave, and Vicente Chave joined the first settlers. With the advice of earlier settlers, the new arrivals traveled down the river, an hour away, and settled on the shores of the Secure River. This site is recognized today as Old Asunta. These kinshipartied families planted mostly oranges and grapefruit and although Old Asunta is now uninhabited, the remaining fruit trees there are harvested yearly.

Finally, another family arrived, that of Juancito Canchi and Juan Tayo. They first built small houses on the shore of the Toñas River near the former group and then moved near the Isinuta River. Their cognate families, such as Espiritu Canchi and Pedro Canchi, who lived separately as a different family unit, later joined these first three migration groups. Although other Tsimane's came later, they chose to go down the river, settling in the area of Oromomo and Areruta where a Yuracare group also settled, coming from the other side of the Secure River. During this period of time, the Yuracare and Tsimane's shared the location, interacted and intermarried. This inter-ethnic relationship was not harmonious because each group lived under mutual threats of sorcery and even death.

The Tsimane' of Asunta also interacted with the Yuracare, especially during the time that game animal pelts were in demand (1960s). At this time, the Trinitarios also arrived in the Asunta area. This group, who were following a religious quest of Holy Hill, stayed in the Asunta area only temporarily before returning to the Isiboro area. During this period, the Tsimane' explored the whole area and established housing in seven places, which can be recognized by trees found in the old home gardens. It was during this period that a landing site of 600m was cleared for small airplanes. There are two explanations for this development. One is that a trader of wild animal pelts forced the Tsimane' to build the landing strip; the other is that a military air force pilot crashed and asked local people to build a landing strip to enable the plane to take off and return to La Paz.

Regardless of why the landing strip was built, this was the only means to reach the community until recently. The area is still relatively inaccessible because there is no road. A motorized canoe trip may take at least one week, while traveling by plane will take about one hour from Trinidad. The establishment of the current Asunta settlement appears to be due to several factors. The landing strip brings sporadic visitors, who bring basic provisions such as batteries, knives, salt and other small necessities. Also, the Tsimane' felt threatened by Yuras and Trinitarios in their ranging territories, so they decided to move closer to the landing strip, where they could feel safe and protect themselves. The landing area is used by the indigenous organization and frequent visitors who have come since the area was declared to be a community territory. Family community houses are settled between the strip and the river and a forest guard-house has been constructed to keep the park safe.

Outsiders, especially local mestizo people, perceive the Asunta settlement and Oromomo area are dangerous places. Indigenous people living in this area were identified as savages who escaped to the forest. This was because the native people challenge the traders and missionaries and rejected market relationships. As in the past, the Tsimane' once again fled, this time to the last corner of the forest. Thus, the current community settlement where people live today is concentrated with an elementary school.

Culturally Tsimane' are highly susceptible to sorcerer accusations or threats. Anything unusual about people or nature may be attributed to *farajtacsi* (sorcery). As soon as the unusual is perceived, people will escape to another location or try to neutralize the sorcery by means of rituals. In some cases, these strategies protect the Tsimane' from foreigners. Close kin may live together, as in Asunta, because they feel more secure in larger kinship groups. Now, because of the indigenous organization and frequent visits from outsiders, the Tsimane' of Asunta are changing and developing more trust and confidence in outsiders.

Asunta people conduct their activities throughout a wide area: they hunt in the Kerosene area to the north; they reach Varujana and Cocapata by following the Secure River south for hunting, fishing and gathering; they go west to the Cavavanza area, a mountainous valley; and they travel east between Cuchisama and Cabito. These are the most frequently mentioned ranging areas for the community. Even with increased distance they maintain contact with their families.

CHAPTER 5
TSIMANE' SWIDDEN-FALLOW DYNAMICS

Introduction to Community Swidden Fallows

Modern Tsimane' communities confront the threat to the continuity of their structural patterns and the need for change that occurs when forest detribalized societies are forced to integrate into national societies from the basis of a profound cultural tradition. These changes, along with sociocultural, economic and environmental concerns, can be examined and understood by addressing the dynamics of local forest ecosystem management. One way to look at these dynamics is simply to emphasize ecological factors, and another way is to assess human influences upon ecological dynamics. Both approaches are integrated here to better reflect the existing ecosystem as impacted by human activities. To this purpose, Tsimane' swidden-fallow management system is the primary concern. This emphasis incorporates cultural and biological parameters to evaluate Tsimane' forest ecosystem regeneration. Factors affecting both short and long term ecosystem regeneration should be considered as part of a strategy for achieving sociocultural and forest ecosystem sustainability.

To assess the Tsimane' swidden-fallow management system, I conducted 16 months of fieldwork during 1997-1999 in Asunta. During my previous short summer visit in 1995, there had been 155 people living in the community. When I returned in 1997 to begin my research, I found only 125 people. Although the community still claims 32 families, I only counted 25 families, 19 to 21 of which consist of permanent residents while the rest migrate between Asunta and other areas of the Tsimane' settlement such as Cabito or Cuchisama. The community is situated on the shore of the Secure River, where residents practice traditional swidden agriculture, fishing, hunting and gathering in the natural forest.

In order to assess indigenous knowledge botanical data was collected and interviews with Tsimane' consultants were conducted. The entire community of 25 families was the sample for this study. These families were interviewed and field assistants were selected from among them to assess fallow plots in the community. Fallow plots of different ages were identified, measured and related to human activities (behavior), and their association with vegetation regeneration was determined.

Tsimane' Swidden Agriculture

Swidden agriculture, one of the most ancient methods of subsistence, is recognized as a less destructive and integrated system (Raintree & Warner 1986). For the Tsimane' area, Piland's (1991) research is one of the most complete studies regarding Tsimane' agriculture. In contrast, other studies concentrate on economics and culture, rather than on agriculture. The Tsimane' annual cycle of activities, including swidden agriculture, is organized under the domain of *yomodye* (yearly cycle), which sets the whole annual activities for every year. This cycle recognizes a beginning of the year marked by the end of the rainy season (Perez Diez 1983).

The beginning of the cycle is marked by the flowering of key trees, such as *o'ba* and *yacañi*. This period of time is referred to as "hunting time" because animals are fattest. Together with this hunting period, the feast of renovation (Riester 1993) is invoked in which *cocojsi'* (shaman) participates or leads the ritual. Around the month of August, *cajñere* flowering begins, indicating the beginning of the dry season and the end of **surazos** (strong winds). When the *cajñere* flower has gone to seed this signifies the beginning of rainy season (Perez Diez 1983). For the Tsimane' the annual cycle integrates these periods of **surazos**, rainy and dryness.

Unlike other Amazonian Indians, the Tsimane' do not separate fishing, hunting, and gathering activities from swidden agriculture (Dufour 1990). Hunting and fishing provide protein and fat and gathering provides other nutrients that are complementary to the carbohydrate staples harvested from swidden. The Tsimane' grow everything in a small amount and usually do not plant perennial trees in swidden fallows. Based on observations and discussions, the agricultural fields were categorized into three types of plots: recent primary forest clearance, secondary forest clearance and fallow plots ranging from 3 to 30 years old. No swidden-fallows of 30 to 45 years old has been observed, though beyond that age they might not be recognizable as distinct from natural forest. In Asunta, most of the agricultural plots lie at the edge of the river, a pattern that is similar to other indigenous groups as well as groups of colonists. As everywhere, agriculturalists look for either a river or a road to transport products to their homes or to markets to optimize their labor costs. The Tsimane' like to cultivate near the river to provide energy (fuelwood) and facilitate the transportation of the products. Likewise, they will choose plain areas where there is no possibility of flooding.

One difference between the Tsimane' and other small-scale agriculturalists is that the Tsimane' do not cut the forests adjacent to each other. This makes ecological sense in this area since regeneration is faster when cutting plots that are not adjacent to each other. The result of this swidden technique is a landscape consisting of a variety of diverse plots interspersed with natural forest galleries.

Using the swidden techniques described below, the Tsimane' plant mainly rice, manioc, maize and plantains. After a short period of use the plot is left to fallow. As a result, there are many types of swidden fallows in the sites used for agricultural areas. The fallows are distributed all over the community lands of the Asunta, from house yards to the primary forest. Adjacent to almost every household settlement there are rich agroforestry fallows, elsewhere recognized as dooryard gardens. Other intermediate swidden fallows that are located from 5 to 10 minutes walking distance from the households tend to be less rich and in a stage similar to secondary forest. Another type of swidden fallow is usually found within a 15 minute to two-hour canoe trip, either in an old secondary or a primary forest stage. These two latter types of fallow were my focus in the study of fallow management in Asunta. Data collection was done at the site of individual parcels while indigenous cultivators were cutting, burning, planting and weeding.

While the main cropping plot matures and is harvested, new plots are located and prepared for annual cultivation. In general, these are not adjacent to the old plots, but near the fallows that can provide first seeds for the new fallows as well as for the new agricultural plots. Second, shifting prevents from diseases and insect breakouts that are usually found in recently cropped plots. New swidden plots cleared are from primary forest or secondary forest and are small in size, no more than ¼ ha. In other cultures, such as among Tukanoans from Colombia (Dufour 1990), polyculture on small plots is typical (0.4 to 0.6 hectares). Many studies emphasize the usefulness of cultivation in smaller plots because limiting plot size facilitates migration and invasion of "biological control agents", such as predators, parasites (Thurston 1997) and even plant seeds from the nearby forests. The practice of small plot swidden farming allows the swidden plots to return quickly to forest succession when they are left fallow because tree stumps and soils are not deteriorated and pest outbreaks diminish.

In the community of Asunta, Tsimane' commonly practice two- to three-year cultivations in old fallow or primary forest areas. The Tsimane' polyculture crop is produced for two basic needs: food for the nuclear family and *shocdye* (manioc beer) for conspicuous social consumption in the community. For these purposes, they mainly produce rice, manioc, corn and plantains. In their gardens Tsimane' cultivate: *binca'*, sweet potato (*Ipomoea sp*.), peanut (*Arachis hypogaea*), sugar cane (*Saccharum officinar*), **ajipa**, pineapple (*Anana sativa*), chile peppers (*Capsicum annuum*) and plantains (*Musa sp*.). Cultivated trees include citrus, cotton, and peach palm (*Bactris gasipae*). Tsimane' crops have different varieties: there are 8 rice, 7 manioc, 6 corn, and 11 plantain varieties.

Tables presented in this chapter illustrate swidden cultivation land use in the community. Most of the Tsimane' cultivate in 5 to 25 year old fallows, and fell trees at 60cm height from soil surface. Beginning in late May, farmers first clear the smaller vegetation, relying only on machetes, and leave larger trees for later. As a result, farm sites are cleared in three phases. Vegetation debris from sequential felling may function as a soil protector. Once the tree cutting begins, family work groups organize themselves to fell the larger trees that are between 2 and 3m in diameter. Although most trees are felled, some, such as palms, are left in the field.

Although at first glance it may appear that the Tsimane' agricultural system is chaotic, their use of resources is highly efficient. For example, the debris left by the felling is scattered evenly throughout the field, as the Tsimane' use their expertise to manipulate felling orientation. Thus, plant residuals completely cover the site and the adjacent forest is not damaged. Before planting, Tsimane' farmers remove some trunks and piles from place to place, but they never make "**basureo**" (to pile leftover debris) as Mojeños or peasants in the area commonly do.

In contrast to the Tsimane', the Mojeño sites are very clean and neat prior to planting, where some large brush is also cut and burned later. My field assistant, who is of Mojeño origin, commented that, unlike the Mojeño, "the Tsimane' do not know how to prepare agricultural plots". The Mojeño make sure that all trees cut are burned.

After felling, Tsimane' leave debris to dry from two weeks to one month, until the seasonal winds begin. Burning then takes place from June to late August. The field at this stage is still full of charcoal, stumps, stems and branches, all of which cover the ground surface. These Tsimane' swidden cultivation techniques, which might be considered as "slash and burn" technology (Harwood 1996), are valuable as an alternative agricultural system because of their low cost and impact to some natural cycles (Sanchez, et al. 1983; Harwood 1996). Therefore, swidden cultivation techniques can be considered a kind of native technology for land use transformation.

During the planting season, which runs from August to November, cultivation takes place gradually. For example, rice planting is distributed over several weeks, so that the growth of crops is synchronized. The result is that fields show a gradation of growing plants. In Tsimane' swidden agriculture, little or no disruption of soil occurs during the cropping period because cultivators dig small holes of 3 to 5cm for cereal seeds with simple technology (such as sticks). Only a manioc plantation requires the use of a machete, for the removal of just enough soil to insert manioc stems. This indentation is then covered to avoid erosion. During the cropping period, weeds are pulled out by the roots. This is especially important during the first year, before the weeds root and flower, to avoid weed propagation. Once crops are harvested, the Tsimane' leave some manioc and then plant plantains and a patch of pineapple, which are managed only by cutting weeds at ground level.

The process of transition from swidden to fallow also merits attention. Most studies tend to characterize swidden fallows as "abandoned fields", but as Denevan & Treacy (1988), Posey (1985) and Thurston (1997) indicate, the fallow fields continue to produce crops. Among the Tsimane', fallows are visited constantly in order to harvest plantain, manioc, peach palm, pineapple and *shuru'* a bamboo-type plant. If the fallow is not rich in these crops, it may not receive attention. But, there are always some old pineapple patches left or other useful plants in the plot, which are harvested eventually such as when game animals are pursued in the area. Fallows are not cultivated in the first three years due to low nutrient levels, weed infestations, and plant pathogens (Thurston 1997). I observed that rice and some manioc are not cultivated any more. People in Asunta are more concerned with birds and game animals than weeds and pathogens.

Despite differences in swidden agricultural practices between the Tsimane’ and other Amazonian indigenous groups, their cropland management and forest manipulation definitely possess dimensions of culture and knowledge. Thus, the Tsimane’ swidden fallows, like those of the Huitoto indigenous people become a “little humanized forest” (Garzón & Macuritofe 1990) which offers an alternative to biological knowledge, agronomic improvement, and forest regeneration.

Swidden and Forest Clearance

Some think that the swidden type of land use has significant adverse effects on the forest. However, the following chart illustrates how much little forest the Tsimane’ clear every year, compared to other groups.

TABLE 5.1 FOREST CUTTING AVERAGE AMONG THE THREE CULTURAL GROUPS (in has.)

YEARS	Annual Clearing Average All groups	Mojeño (51 families)		Yuracare (40 families)		Tsimane’ (40 families)	
		Primary Forest	Secondary Forest	Primary Forest	Secondary Forest	Primary Forest	Secondary Forest
1996	1.79	0.48	0.41	0.25	0.33	0.22	0.10
1997	2.40	0.59	0.69	0.28	0.45	0.24	0.15

Table 5.1 shows a summary of current agricultural plot sizes for three communities in the Isiboro-Secure National Park[3]. The results show that primary and secondary forest clearing annual averages range from 1.79 to 2.40 ha for all groups. The

amount of land cleared yearly by Timane' is small compared to other groups in the park. However, the land use system becomes extensive rather than intensive, as is the case with other groups.

The forest cleared by the Tsimane' in Asunta for swidden cultivation falls into two categories: one in primary forest areas and the other in the secondary forest areas. Both the primary and the secondary forest areas are located on the river shores and within the nearby forests close to the community. The average area of primary and secondary forest cleared by each Tsimane' in Asunta for 25 households and in three consecutive years was: 0.10ha in 1996, 0.28ha in 1997 and 0.33ha in 1998 (Tables 5.2 and 5.3). At the community level the average cleared was 1.18, 3.5 and 4.12 hectares respectively for each year. Data presented in Table 5.2 indicates a larger increase in forest clearance than Table 5.1. I attribute this discrepancy to two sources. The first, since Tsimane' people frequently leave the community temporarily, the answers to the survey in some cases were given by an individual who was not the head of the household. In other words, the survey was given to any person present in the household. Second, data in Table 5.1 comes from a survey based on perceptions, whereas the data in Table 5.2 is based on physical measurement.

It is clear that both primary and secondary forest is cleared for agriculture. In 1998, the members of the Asunta community cleared about 4.83ha of primary forest and only 3.40ha of secondary forest. This small difference represents the general trend for clearing forests in Asunta. However, these averages may tend to change according to the notions of land tenure security, market integration and eventual misfortunes that may

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[3] Data for 1996 and 1997 in Tables 5.1 and 5.2 come from surveys conducted in 1997 in the Isiboro-Secure

increase forest clearance since the forest functions as safety net for livelihood (Godoy 1998).

TABLE 5.2 COMMUNITY FOREST USE FOR 25 FAMILIES

Forest Category	Total Cleared			Clearance space distribution, 1998*				
					Cultivated		Non cultivated	
	Ha 1996	Ha 1997	Ha 1998	%	Ha	%	Ha	%
Primary forest	1.7	3.58	4.83	100	3.94	81.5	0.90	18.5
Secondary forest	0.66	3.42	3.40	100	2.46	72.4	0.94	27.6
Total	2.36	7.0	8.23	100	6.4	77.7	1.84	22.3
Total Average Community	1.18	3.5	4.12		3.2		0.92	
Total Average Individual	0.10	0.28	0.33		0.26		0.07	

* Distribution of forest cleared - only estimated for 1998

Tsimane's tend to cultivate one plot from primary forest and another from old fallow. Some prefer to maintain the fallows instead of clearing new ones. The estimated amount of total land cleared (primary and secondary forest) for whole community in 1998 was 8.23 ha, in which 3.2 ha was cultivated and 1.84 was not cultivated and presumably left for forest regeneration. The total area cultivated from primary forests is 81.5% and from secondary forests is 72.4%. Thus, it follows that the area of land cleared without cultivation is 18.5% in primary forests and 27.5% in secondary forests.

Leaving parts of cleared fields uncultivated may be an important factor in fallow regeneration. The uncultivated area is not burned along with the agricultural area, but is left to regenerate immediately. Cutting this space around the area burned is important for preventing the fire from spreading into the surrounding forest around the planted field. Usually, root masses and stumps of trees that were felled during the period of site

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National Park with Dr. Ricardo Godoy.

preparation remain intact even after burning. In fact, the Tsimane’ observe that “they are full of water”, and these plant remains are not destroyed by burning. Thus, cutting the additional area actually serves to conserve the amount of forest impacted by agricultural activities.

Following the Tsimane’ practice of swidden cultivation of second and third year fallows, neotropical forest regeneration is evident because fields are sprouting. In Asunta, I visited swidden plots shortly after cultivation and noticed new shoots sprouting from stumps in cultivated and non-cultivated areas. New seedlings were not noticeable, but coppice shoots and sprouts regrow quickly at the beginning of the swidden cycle. A general survey of a range of old forest fallows in Asunta further reveals that there are a significant number of trees sprouting from existing stumps. This shows that swidden cultivation does not damage the ability of this aspect of the plant regeneration system, at least for some species. The trees of different sizes are, in fact, cut and burned, but the stumps are the bases for regrowing and regenerating new trunks and stems. Indeed, below ground level, the root masses are not affected by burning. Likewise, surface soil and the soil structure are not laterized by fire or changed by cultivation, a fact that favors forest regeneration.

Swidden Fallow and Preferences on Forest Use

The fallow type of selection varies according to many factors including time, tree species, thickness of regrowth, and labor availability. The Guarayo indigenous group in Santa Cruz (Bolivia), for instance, determine fallowing time according to the labor demanded for felling and time to dry tree debris, not according to the level of regeneration of fallow fields. In fact, the Guarayo fallow selection appears to be conditioned by the time dedicated to extra agricultural labor outside of the community and for earning cash income (Adlard et al. 1996).

Age of workers is not a limiting factor for clearing high forest among the Tsimane'. Usually work is done with the elder son. Although there is no cooperative institution in the community such as among the Guarayos, Tsimane' may ask family members for help. Widows among the Tsimane' are rare, as men and women do not stay alone after their spouses die. The woman usually moves to her sister's house, while a widower may move in with his wife's sister or another female relative. This is because of division of labor; men hunt and fell the trees while women take care of crops and make *shocdye*.

With respect to plant thickness, the Tsimane' observe the *cajñere*, which is a fast-growing plant. Guarayos prefer to cut 60cm circumference at (dbh) height fallows, which is similar to Tsimane' selection. The 60cm height (yuguaruniti plant) found usually in fallows is another indicator used among the Guarayos. Certainly these indicators might not be standardized because of different ecosystems, soil fertility and plant species available.

The Tsimane' land use does not show a marked preference for clearing primary forest. Rather, there is a balance between secondary and primary forest. Likewise, there is no evidence of swidden fallows more than 40 years old, or possibly they are not able to recognize them. The data presented in Table 5.3 for the whole community shows the categories of plot distribution in Asunta.

TABLE 5.3 NUMBER OF SWIDDEN FALLOW PLOTS IN ASUNTA
(19 families)

YEARS	Parcels in use				Parcels in Fallow	Total community Parcels
	Primary forest No. Plots	%	Secondary forest No. Plots	%	Number of Fallows	
1996	25	59.5	17	40.5	---*	---*
1997	20	52.6	18	47.4	99	137
1998	17	47.0	19	53.0	72	108

* data has not been estimated for 1996

The interviews on clearing plots for 1996 and 1997 show that primary forest is almost equal in size and in a numbers of plots cleared each year, but data from personal inspection in the field is a bit different. Primary forests and old fallow are equally cleared. In 1998, the Tsimane' Asunta community had 17 new swidden plots, 19 swidden fallows cultivated, and 72 plots left to swidden fallows. The average of fallows per family is about 4 plots for 19 families. Not all families may have new plots because the Tsimane' like to maintain formerly cultivated plants while they visit family. This reveals that the pattern of Tsimane' land use system is one plot in primary forest and one plot in secondary forest. Secondary forests are felled after approximately 5 years of fallow, while 25 year old fallows might be considered primary forest.

Swidden fallow dynamics are circumscribed as to local human dynamics, physiographic characteristics and agricultural cycle. For instance, the Tsimane' of Voseruna and Cuverene live close to the Asunta community but in flatland forest area. The pattern of cultivation is similar; however, the average of land use is double, 0.62has per domestic unit compared to the Tsimane' of Asunta. The period of land use size is two to three years and then left to regeneration. Fallow reuse is about every 6.7 years as an average (CIDDEBENI 1990). These differences might be related to the size of the opened fallow and to the local ecotype and frequent contact with loggers.

In the case of Asunta, along with community formation, swidden and fallowing are guided by climatic changes and by observing the natural vegetation. Tsimane' fallows are located at three levels of space. The dooryard garden, the intermediate-distance fallows and the farthest fallows. Plots are cleared not adjacent to each other and cultivated always in policultural type. The clearance of primary and secondary forest is balanced and each plot cleared is about ¼ ha. The opened plot is systematically covered over after every activity. At the beginning, burning leaves some patches; when planting only patches cleaned are used. After harvest only some useful plants are maintained, showing a process of fallow regeneration. When the fallow is considered mature enough by certain plant indicators, the fallow will be ready to begin another agricultural cycle. Although the data illustrates the conservationist aspects of the Tsimane' people, indigenous populations are facing the threats of integration into national society, which will certainly affect the community in many different ways.

CHAPTER 6
SWIDDEN FALLOW REGENERATION AND MANAGEMENT

Introduction to Tsimane' Swidden Fallow

In the last two decades, because of environmental problems associated with tropical deforestation, ecologists and developers have paid increased attention to the issue of forest management (Fujisaka et al. 1996). Community resource management and swidden agriculture are part of the debate. Indigenous agriculture has long been stigmatized under "slash-and-burn" agriculture and some people are still skeptical of indigenous swidden cultivation. Many do not consider indigenous natural resource management a legitimate alternative.

Studies focusing on what types of people are controlling or manipulating the forest in order to optimize benefits has shown a great variety of indigenous management practices related to native agriculture and forest resource use. The two broad ecosystems associated with this management are the forest and the areas of swidden cultivation. Posey (1985) and Balée (1994) demonstrated that indigenous cultivators also manage the natural forest. In addition, more recent studies demonstrate by collecting forest products, some gatherers were in fact beginning to manage forests (Wiersum 1997). Forest inhabitants manage their environment, in which the central aspect of indigenous management is without doubt the swidden fallow management system, one directed to success for agricultural systems (Ewel 1986) and second, to forest ecosystem regeneration.

However, despite centuries of involvement of forest dwellers in forest management, many people think that indigenous people are changing from subsistence to market-oriented production. They argue that indigenous swidden cultivators are losing their traditional respect for the forest due to outside influences. Further, the availability of health care can create problems because it means there will be less mortality and growing populations (Brady 1996). They expect more forest clearing, decreasing fallow periods, and more demand for agricultural land. The process will break down the culture (subsistence system), with a concomitant loss of indigenous knowledge. However, these changes are differentiated even within the same ethnic group, such as Tsimane'.

Tsimane' experience is certainly varied. There are people in contact with missionaries and some who live with colonists and logging companies. However, Tsimane' from the Secure area have avoided these influences. Regardless of which processes have affected the Tsimane', their management system of swidden fallows also appears to be affected. Historically, missionaries did not contact the Tsimane' successfully until after the colonial period. However, from the 1950s onward there have been two missionary groups attempting to control and teach a "western style" of living to the Tsimane'. The Catholic missionaries introduced the mission of Fatima in 1953, and they attempted to introduce cattle ranching and perennial plant cultivation, such as cacao and coffee (Chicchon 1992). During the same period the "New Tribes" missionaries (Protestants) also attempted to control the Tsimane' by establishing two educational centers, one in La Cruz and the other in Horeb near San Borja.

During the 1980s the Bolivian government colonization project was initiated along the Yucumo-Rurrenabaque road, which caused the abandonment of some Tsimane' communities. Others were forced to live under the colonization system (nucleated), which is incompatible with the land use system of the Tsimane'. This interethnic relationship highly affected the Tsimane' socio-economically as they worked for the colonists and began to clear about 2 hectares of forest annually for rice and monocropping (Silva 1997). Since the 1990s, in the areas under the Tsimane' Forest Project, indigenous participation and forest management have been emphasized. However, economic and culturally integrated participation has become very ambiguous. Tsimane' in the area are being forced to sell lumber and induced to raise cattle. Indeed, Tsimane' economy and agriculture has varied depending on where they live and who they are in contact with.

There are other groups such as the people of from Asunta, Oromomo and Cuverene that have escaped these processes. They did not want to remain within the Tsimane' main territory with intruders, and they went to live far away, in isolated places. These groups tend to strongly conserve their traditional system of natural resource management. What I just outlined may show socio-cultural stratification: Tsimane' with missionary influences, Tsimane' with colonist influences, and Tsimane' with less outside influence. This attempt at classification shows a broad and complex variation of Tsimane' integration to socio-economic processes.

Tsimane' Swidden Fallow Management

The indigenous management system and its associated activities should not be equated with changing factors such as ecology, technology, and socioeconomic drivers. Indigenous people have historically perceived and coded into their cultural systems activities generated from internal experiences. Many consider surrounding objects to be alive, comparable to humankind, with spirits. So management does not necessarily respond to changing conditions as it is viewed in current circumstances (Wiersum 1997). The underlying relationship is subject/object (human/nature), which comes from when the human beings are detached from their immediate environment. This separation has led human beings to over-exploit nature resulting in the pressure on the forest and non-sustainable land use practices. The modern management awareness comes from urban areas rather than from rural areas, and managers trained in modern procedures tend to measure swidden agriculture from this management point of view. In this regard, to approach the indigenous management system, should forest managers and scientific agronomy variables be used as management indicators to measure the viability of swidden agriculture? Or in contrast, is it possible to approach the subject in terms of indigenous perceptions?

In tropical America several types of traditional indigenous fallow management systems have been described. In this chapter a few have been named, including those techniques involving planting and selecting species for fruit, fuelwood, or timber. These fallows are maintained by local populations over long periods of time. Crops are used for household consumption, and for sale in the local market (Hammond et al. 1995, Montagnini & Mendelsohn 1997). It should be asked: when does the interest in agroforestry system arise or what are the conditions that make indigenous people change from fallow to agroforestry? It appears that not all indigenous people will develop this kind of agroecosystem. Most likely those who will develop agroforestry are people who are market integrated, well established, detribalized, and with land tenure security.

Swidden cultivators involved in market integration exhibit a cash economy, increased interaction with outsiders, and sedentarization or urban-type structure of community formation, which creates private landholding rights instead of land based on territorial identity. In other words, indigenous people already in the process of becoming "peasants" tend to plant perennial trees, which go along with cash crops and the land tenure system. In fact, community integration into the private land tenure system guarantees the inheritance of parcels enriched by fruits and timber trees.

Studies on indigenous fallows have demonstrated improvement of agricultural ecosystems. Thus, many people concerned with forest conservation have proposed the system of fallowing as a management alternative for swidden cultivation in the tropics (Unruh 1990, Hammond et al. 1995). Fallow vegetation regeneration should not be confused with successional vegetation dynamics. From an ecological point of view, succession refers to a natural regrowth of vegetation, often perceived as an orderly process of the regeneration of populations. In the long term succession is expected to achieve the original structure and composition of the forest. Egler (1954) emphasizes the role of the initial floristic composition, in defining the dynamics of successive vegetational regeneration. This may occur after natural disturbance but not in places where humans disturb purposefully, as among the Tsimane' forest.

I would also argue that Tsimane' fallow-based agricultural production does not tend to develop into an agroforestry system. First, temporal cropping is not oriented to planting economic trees. Second, planting native trees occurs, but no more than one or two trees are involved. Third, pineapple and *shuru'* are the most commonly cultivated plants which integrate woody and herbaceous components. In sum, Tsimane' cultivation in the area seems more adequate, self-sufficient, and rich in cultural meanings. Fallow periods of 15 to 25 years are long enough to regenerate secondary forest in the view of Tsimane'.

Fallow Categories and Management

In their language the Tsimane' call fallow sites *cum*, meaning any kind of fallow. When they want to specify the stage of fallow, they have four terms that refer to swidden fallows: *munjavias, prujmas, ishu quejodye,* and *uracyas*. These terms do not reflect the exact age of the fallows, but rather designate broad groups of gradual aging of fallows, which range between *moises quejodye* (new cropping plot) and *uracyas* (old fallow). As in other indigenous agriculture, there is no deliberate transition from cultivated land to a secondary forest, nor are there fixed marks to indicate when a certain swidden plot passes into the *cum* category. Dufour (1990) asserts, for areas of the Amazon, that the transition from swidden to fallow is not sharp, and in the Indian's perception the swiddens are not abandoned. In contrast, they contain useful plants and are managed until they are closed by forest.

Tsimane' fallows appear to follow this pattern too. After the main harvest the whole plot is no longer cultivated, but some patches in the plot are maintained where some cultivated and non-cultivated plants remain. As in the Bora indigenous culture, Tsimane' swidden fallows appear to go through certain stages in which the field capacity of production changes gradually from cultivated plants to forest field (Denevan & Treacy 1988). In general, because of reduced maintenance of their circular shape, and the presence of surrounding trees the small plot tend to be colonized rapidly and vegetation recovers almost immediately. However, these Tsimane' swidden fallows, although they belong to "enriched fallows of the Amazon" (Kass et al. 1993), do not tend to "economically enrich" the Tsimane' but they do "biologically enrich" plants for domestic use.

A remarkable difference between Asuntas' Tsimane' and other indigenous groups in the area is their conception of shape, size and "cleanliness" of plots. Today most of the indigenous groups have become very oriented to square-shaped plots. They no longer tend to clear in a circular shape as do the Tsimane' of Asunta. This is because most of the technicians, agrarian reform institutions, missionaries, and other institutions based on western agricultural backgrounds influence them regarding the shape and cleanliness of the plot, seed use and crop productivity. Even worse, many farmers and colonists remove tree roots in order to create square plots with straight rows, to facilitate measurement and to prepare soils for cultivation as in temperate areas. In contrast to these patterns, the Tsimane' from Asunta generally do not clear square plots. Most of the swiddens are circular in shape, are small, and fields do not have straight rows of crops. This pattern of management is important, since "spatial aspects" (i.e., size and shape) is another component in management that may influence regeneration of vegetation. Therefore, edge effects and "spatial aspects" have to be taken into consideration when vegetation regeneration is involved (Denevan & Treacy, 1988).

Technicians of modern agriculture tend to speak in terms of hectares for cultivation, calculate productivity, and if the plots are small and shifting, they recommend that the indigenous clear plots next to each other to increase efficiency. The size of the plot needed seems poorly understood by developers, which not only has to do with productivity of the crop but also with forest regeneration and environment productivity. The idea of clean, straight plots comes from modern prevalent society and actually works against forest regeneration. Indigenous people in the Asunta area chop down the forest and they do not clean up the sites, and between plots they usually leave forest galleries as if they were buffer zones which also functions as windbreakers.

Swidden Cropping Plots per Household and Management

The nineteen Tsimane' families interviewed had a total of 108 parcels in 1998. The parcels have been grouped mainly in two functional groups: parcels actively in use number 36, and 72 parcels are in fallow (See Table 5.4). The Asunta have five age categories in which the first three categories (up to 15 years old) are in abundance (See Table 7. 4). Fallows from 3 to 5 years are the most abundant followed by 6 to 10 year-old fallows. In contrast the fallows within the age 16 to 20 tend to decline, and there are only a few fallows 25 years old. This pattern might indicate land use system in which more aged fallows are preferred for cutting and initiating the new cycle of swidden cultivation.

Irvine (1989) indicates that fallow forest resources are altered during the fallow period. While fallows are in a regrowth process indigenous people favor some fruit, construction, medicinal and fuelwood plants. Tsimane' alter the fallow forest by cutting and eliminating undesirable vegetation. In addition, they plant and protect useful species for food consumption, making hunting instruments, and for household domestic use. Tsimane' fallow management can be understood by looking at specific indicators: methods of cutting, planting, harvesting, and clearing.

Swidden plots are usually managed based on household decisions that define the patterns of clearing, harvesting and planting. These decisions contribute to the regeneration of plant composition in lands used within the primary and secondary forests. At the time of forest clearing for cultivation some valuable plants - both over story and under story- such as palms and other trees, are left on the plot. The process of selective cutting continues during the cropping period, which favors certain forest species as sources of fallow regeneration. Plants found in fallows are managed for several purposes. One fallow species, peach palm, is a multipurpose plant and is highly managed. Table 6.1 shows the pattern of selective cutting during the plot preparation for cropping:

TABLE 6.1 SELECTIVE CUTTING AS A MANAGEMENT METHOD
(From plots cleared in 1998 by 19 families)

Forest Category	Househ. %	Number of plots Surveyed	Total Number Of trees Left	%	Plant categories			
					Fruit Trees %	Palm Trees %	Woody Trees %	Narcotic Trees %
Primary Forest	36.0	18	24	100	16.6	41.6	37.5	4.1
Secondary forest	20.0	14	15	100	0.0	33.4	66.6	0.0

During clearance by 19 households, 36% left entire or partial trees during plot preparation in primary forest. The trees left consist of four plant categories: fruit trees 16.6%, palm trees 41.6%, woody trees 37.5 % and narcotic trees 4%. This demonstrates that some Tsimane' do not cut some trees and palms that are highly appreciated for household maintenance. By contrast, in secondary fallows, only 20% of family heads left trees in their plots, in which 33.4% are palms and 66.6% are woody trees. Woody trees compared to palms and fruit trees are protected for construction materials - especially for house building or for canoes- and these are almost universally protected among indigenous people, although some species may not be as valued where they grow in abundance.

Within the plots, the Tsimane' distribute crops in a way that allows vegetation growth, not to optimize production. The typical Tsimane' crop pattern is polycropping. All of the fields that I visited were under a polycropping system. Nobody cultivates all the different crops at one time. Rather they crop gradually during the planting season to lower the risk of loss.

At the beginning of the fallow there are no perennial plants in the plot. However, there are species used for household consumption that are especially important to women and children. Edible fruits are a major staple food, and are usually the first to be cultivated in fallow. Some species are progressively planted during the period of cropping and are left after harvest to attract game animals. In addition, there are some plants used for fish poison, which are planted when fallows are visited.

To evaluate how the Tsimane' manage fallows I asked if they had planted any crop in their last two visits to their field. Of the 20 families interviewed, only 5 reported actively planting crops in fallows, while the rest did not plant at all. Among those who planted, the amount planted was very little (as illustrated Table 6.2). These findings were unexpected, as swidden agriculture usually involves the recurrent planting of species in fallows, in which domesticated and semidomesticated trees are planted at different fallow stages. Further, as crops mature people tend to substitute with other fallow plants and care for them selectively, deliberately or unconsciously. Thus fallows become enriched and managed. This process apparently does not occur among the Tsimane'.

TABLE 6.2 PLANTING ACTIVITIES IN LAST FALLOW VISIT
(20 families)

CROPS PLANTED	Young fallow (1990s)			Old fallow (1980s)		
	Number Of families	Number Of seeds	Units Planted	Number of Families	Number of Seeds	Units Planted

Manioc	1	3	12			
Pineapple	2	8	8	1	5	3
Cojcoj	1	2	6			
Sugar cane	1	4	5			
Total	5	17	31	1	5	3

The results in Table 6.2 have been organized in young (1990s) and old fallows (1980s). The reported estimations were different in terms of planting activities but similar in terms of the species planted. The most commonly planted crops are manioc followed by pineapple, which is perennial and should be considered a fallow plant among the Tsimane'. It appears that in every visit there is a small amount of planting activity. Small patches are planted by plantain and pineapple in the fallows, but decrease as fallow becomes older. No forest or fruit trees were planted during the last fallow visit.

One of the more valuable management attributes of swidden-fallow is the tendency to use fallows for agroforestry production. In this respect, although Tsimane' do not seem to plant trees, the harvest data show a greater frequency of useful trees in old managed swiddens. These trees come from trees left uncut while clearing the forest, and trees planted in the early cultivation cycle. Methods of succession management may vary but planting, protecting, and selecting are the most practiced while a plot is in production. Although intensity of maintenance may be lower during the fallow period, they may dedicate their activities exclusively to the trees harvested when fallows are visited sporadically.

Harvesting as Management Indicator

Contrary to persistent beliefs that indigenous fields are abandoned after a few years of cultivating and harvesting, recent studies show that swidden fallows are managed because of highly diverse natural resources planted during the first period of the swidden cycle. The fields of the Kayapos have been widely recognized for continous production in so-called abandoned fields. Products such as sweet potato, manioc, papaya, plantain and others remain in young fallows and Kayapo as well as Bora and Ashuar indigenous people are motivated to visit old fields (Posey 1989, Denevan & Treacy 1988, Descola 1994). Further, the older a swidden fallow gets, the more the domesticated and natural regeneration seem to occur, which provides a wide range of products like food, medicine, and fiber. Regarding Tsimane', I asked about plants harvested in recent and during the last year visit to the fallows. The Table 6.3 explains the results.

TABLE 6.3 PLANTS HARVESTED IN LAST FALLOW VISIT
(20 families)

PLANTS HARVESTED	Young Fallow (1990s)			Old Fallow (1980s)		
	Number of Families	Types of Plant part	Units Harvested	Number of Families	Types of Plant parts	Units Harvested

Manioc	3	Roots	39	1	Roots	1
Peach palm	2	Stem fruit	10	2	Stem fruit	2
Pineapple	3	Fruits	20	3	Fruits	16
Orange	2	Fruits	210	1	Fruits	125
Plantain	8	Bunch	31	3	Bunch	3
Sugar cane	2	Stem	7	-	-	-
Manai	1	Leaves	5	-	-	-
Shuru'	1	Sticks	106	3	Sticks	350
Cajñere	-	-	-	1	Bark	1

Table 6.3 shows that, among 20 households surveyed, almost all harvested crops planted in young fallows, but that household visits and harvesting generally drops in older fallows. Both fallows (young and old) show nine plants harvested, consisting of domesticated trees such as orange, plantain, and pineapple, and semidomesticated plants like peach palm and *shuru'*. Some manioc and sugarcane remain in the plots, which usually are maintained as a seed bank in small patches. *Cajeñere* is also mentioned, which is a fast growing fallow tree highly used for ropes, toys or for rafts.

The frequency of use and the quality of use are important to distinguish among the plants harvested because they are not cultivated in the same amounts in terms of size or units. For instance, only one peach palm may be planted in a plot, but it will sprout into three, five or more. Therefore, it is enough to have a few peach palms in a plot. Similarly, there would be a few *shuru'* at the beginning, but in a few years it will spread by its underground roots. It has to be controlled and maintained in a size small enough to provide flower stems for making arrows. Pineapple has to be cultivated, but conserved during the years in fallows. It usually does not disappear even if the fallows are not managed. Other trees like orange and plantain have to be planted near the community for easy harvest. Some of these crops can be harvested every visit while others can only be harvested once a year.

Among the Tsimane' plants mentioned, some, such as peach palm and *shuru'*, are closely linked to socio-cultural practices and the belief system. In reality, Tsimane's believe that every plant has an *amo* (protector) that regulates the behavior for planting, cutting and harvesting it. This topic is explained further in the section on Tsimane' cultural correlates. Indeed, for many tropical societies, the forest has a spiritual partner that takes care of the forest. The clearing of swidden demands observing the rules that regulate the relationship between forest partners and local people. Changes in ways of living may affect not only the management of swidden fallow, but also social and ecological patterns of coexistence.

Clearing and Weeding Techniques of Management

One of the management methods common to all agricultural systems is removing undesirable plants, including weeds. Until recently, agricultural scientist focused mostly on weed control instead of weed management. Only recently has weed management been introduced into the agricultural and ecological fields. As in other aspects of agricultural management, empirical knowledge from agriculturalists and indigenous people from the tropics included the bases of weed management. One of the studies dedicated to jhum system in Asia provides vast information on weed manipulation that illustrates how an agroecosystem may benefit from weed management. For instance, short cycle weeds conserve soil nutrients, protect the soil from erosion and recycle nutrients (Ramakrishnan 1992).

Among Tsimane' weed-suppression seems not to be a problem since they do not cultivate larger crops. Of course, pulling and cutting weeds occurs during the period of growth to protect crops. The easiest way to get rid of weeds is to leave the sites to fallow and the Tsimane' know, as do other indigenous people that weeds will disappear through the process of succession (Rouw 1995). To Tsimane', weeds are not a threat for land re-use. They do not consider the best cropping time to avoid weed growth or pests as the Mojeño attempt to do, to lower the risks of production (Table 6.4). The management of undesired plants in fallow plots is as follows:

TABLE 6.4 MANAGEMENT BY SLASHING OR WEEDING AROUND PLANTS IN LAST FALLOW VISIT (20 families)

	Recent fallow	Old fallow
Percent of Families Who Managed Fallow Plants	80.0	60.0
Average time worked (Hour)	1.43	2.5
Number of Plants Managed	46	36
% Domesticated	82.0	58.3
% Semidomesticated	17.7	36.0
% Forest trees	0.0	6.0
Number of Plants Eliminated	22	15
% Grass	9.0	0.0
% Weeds	54.5	40.0
% Paya	13.6	20.0
% Shrubs	22.7	40.0

Among Tsimane' from Asunta community, 80% of the members of the community cleared and weeded around the plants in recent fallows while visiting swidden fallows. In contrast, 60% of the members of the community also cleared and weeded old fallows. The average time dedicated to clearing and weeding in each type of fallow is 1.43 hours for recent fallows and 2.5 hours for old fallows.

Eleven species of plants were cleared in the new fallow compared to 10 species in the old fallow. These plants were classified by the community as domesticated, semidomesticated and forest plants. In a recent fallows, domesticated plants totaled 82.2% and semidomesticated 17.7%. There was no other category in this type of fallow. Older fallows seem to have wider variety of plants. In old fallows, domesticated plants accounted for 58.3%, semidomesticated 36 %, and wild plants 6%.

In respect to plants that are removed, there appear to be four categories in recent fallows: *biruruc* accounts for 54.5%, shrubs for 22.7%, *paya* for 13.6% and *vijyo* for 9% of all plants removed. The percentages in old fallow are slightly different. *Biruruc* accounts for 40%, shrubs for 40%, and *paya* accounts for 20%. It is interesting that *vijyo*, a persistent weed, disappears in old fallows.

In fact, Tsimane' recognize at least two types of weeds, *vijyo* and *biruruc,* both considered useless. Fallow period functions as a weed-suppression because of the shading. Trees and coppice shoots will suppress weeds within three years or more. Studies among Tai indicate that suppression normally takes 4-6 years and may even take10 to15 years (Rouw 1995), much longer than the time required for the area studied. Weeding occurs two or three times during the period of crop growth, mostly when weeds are 20cm high by pulling them by the roots. After harvest, most people do not weed unless the patches contain manioc or useful trees. Trees such as peach palm and bamboos are protected from immediate weed pressure and progressive regrowth of shrubs, lianas, and tree saplings. The second period of more intense weed management occurs after five years of fallow. At this time the swidden fallow is almost covered over. Where there are palms and bamboos, an area of three meters surrounding them is cleaned by machete at least two times per year. Other plots without any useful plants remain under canopy cover, sometimes visited to harvest some poles or bark, until the Tsimane' consider the plot mature or until it is needed for a new cropping cycle.

Weed-suppression as well as soil restoration are important. Tsimane' management techniques contribute to both by allowing some plants to grow and leaving plant debris on the ground after clearing rather than burning. Shortened fallow periods and the degradation of forest structure, raised in the literature all over the world, does not occur yet in Asunta. It a future deterioration may happen, but the reuse of fallow not only depends on fallow ages but also in the types of vegetation regrowth, climate, and temperature. Indigenous people of the area always refer to old forest as that of 10 years or more in fallow and I have not seen fallows reduced to grassy areas or shrubs. As I said earlier, this may be explained in the area of study due to the size of parcels that are cleared, abundant open forest for cropping, and the purpose of farming, which is family subsistence oriented. The Tsimane' do not talk about abandoning fallow because of weeds, but they do discuss abandoning cropland that is flooded. The family controls weeds by sporadic visits in which they usually weed only around plants they expect to harvest.

Although Tsimane' people in Asunta are experiencing cultural change, they continue to practice their traditional fallow management system. There are four categories of fallow among the Tsimane' that are managed, but are not oriented to agroforestry system as among other indigenous groups in the Amazon. Their fallows are enriched not by planting desired species, but by selective cutting and by protecting plants, practices that begin during the process of plot preparation. Fallows are left long enough to regenerate native vegetation, a process favored by the shape and the size of the plots and the method of burning used. Three types of plants tend to occur in managed fallows, peach palm, *shuru'* (a bamboo like plant) and pineapple. Weeding and clearing also are practiced during the year only around the useful plants. The plants that are left and managed are harvested annually. Tsimane' management may fit in Balée's (1994) definition of management, in which humans manipulate environmental components and make the natural forest different and diverse in a particular region. However, they improve rather than degrade the existing environment.

Sexual Beliefs that Affect Management and Population

Sexual abstinence is also practiced. A Tsimane' male, for instance, believes that he cannot have sex with his wife from the time she becomes pregnant to six months after childbirth. The explanation given is that the woman and child have an odor called *achijchi*, which is displeasing to forest spirits. Sexual repression is documented among other Amazonian Indians as well as among the Tsimane'. Sex is avoided the night before labor-intensive activities such as building houses, constructing canoes, fishing with ictiotoxics, making manioc beer (*shocdye)*, planting crops, and so on. It is believed that to violate the restriction causes the protective spirits to become angry and cause illness, or other bad consequences such as canoe accidents.

Two words constantly repeated that are related to sex relations are *achijchi* and *jarajray*. The odor after sexual relations is *jarajaray* and most often is relegated to males. The *achijchi*, the odor as in meat rotting, is less powerful than the former term and it is used for both men and women. The newborn child and mother keep the odor from four to six months and men can be contaminated if they get close or have sex. Males are very cautious in this matter because *mocu muntyi* (the mountain guardian) does not like the odor and may prevent the Tsimane' from success in hunting. Animals may smell the odor and escape, or the hunter may never be able to get close to the animals. In contrast, *achijchi* attracts forest spirits that want the child's soul. A hunter who disregards sexual avoidance rules may be followed home by spirits that can steal the child's soul or make the mother ill.

Ritual practices and activities demand sexual restriction. Tsimane' observe that certain agricultural activities, such hunting animals, fishing and collecting some forest resources require sexual continence, and along with this, dietary restriction is also practiced. During the gestation period, for instance, there are fish with skin, animals with teeth like tapir and deer, and fruits such as *bejqui* and *manai* that must be avoided. The eating of these food sources may cause sickness to the child and mother.

CHAPTER 7
SWIDDEN FALLOW PLANT INVENTORY AND KNOWLEDGE

The Fallow Vegetation

Once the original forest is cleared and transformed for cultivation, there is a continuous agroecosystem disturbance in any swidden system (conuco, jhum,) due to burning, planting, weeding, and other agricultural activities, until the cropping cycle is completed. These processes affect the nutrient status and the animal populations of the ecosystem. Cropping also directly affects the vegetation of the fallow, producing variability in its structure and species composition (Ramakrishna 1992). Changes during the fallow not only depend on the abruptness and timing of activities distinguished by Uhl et al. (1989) (natural and anthropogenic disturbances), but also on the people's knowledge, culture, and relationship to markets.

What are the implications once forests are converted into agroecosytems? Jordan's (1996) San Carlos study emphasizes nutrient stress as a main factor for crop and biomass production. In contrast Uhl (1987, 1989) discusses regenerative mechanisms as major factors controlling succession, including microhabitat conditions and nutrient availability in human-disturbed habitats, such as swidden cultivation plots. Both studies demonstrate the complementary ways in which the structure of an ecosystem operates in a disturbed tropical forest.

I do not consider nutrient and biomass accumulation, but rather examine the Asunta fallow in relation to regenerative mechanisms. First, regeneration capacity is dependent on sprouting of cut stems and the availability of seeds at agricultural sites. According to Uhl (1987), the capacity for seed germination can be affected by repeated weeding, resulting in reduced and exhausted regenerative reserves. As a result, the species composition of the forest changes, shifting from pioneer trees to herbs. I cannot confirm that this occurs in Asunta because there is no repeated weeding and the plots are not used repeatedly during a short time.

The second factor is microhabitat, which may guarantee seed germination and seedling establishment. Experiments have shown that primary forest tree seedlings can survive and grow in fallows as long as shade is available (Uhl 1987). The results of the experiments illustrate the importance of shading where pioneer tree species were more abundant in shaded areas than in the open fields. Thus, protection from solar radiation could be an important factor. Among the Tsimane' I observed that most vegetation grows fast, reaching more than two meters height in a few months, depending on species that create diverse shading patterns. Thus, this protects from solar radiation impact and even generates diverse microclimatic patches. Further, the prevailing foggy and cloudy conditions of the area diminish the solar radiation effects.

A third consideration in swidden agriculture is nutrient availability since slash and burn is associated with the loss of large amounts of above-ground organic matter and substantial amounts of nutrients. However, soil nutrient concentration in fallows has been found to be similar to uncut forests (Uhl 1987). In Tsimane' fallows, from the beginning of cropping, plots have high levels of organic accumulation since only small patches are cultivated and the debris left in the field helps maintain nutrient level in the soil.

Specific assumptions derived from regenerative mechanisms and the fact that indigenous swidden cultivation is suited to the forest environment makes it appear that forest is functioning as it did in the past. Further, given that there has been no factor such as new technology adoption, population increase, and climate changes in the past there would be no drastic changes in vegetation regeneration and patterns of succession (Peters & Neuenschwander 1988). Therefore, Asunta swidden fallows rely only on the local management system and knowledge that they have along the Tsimane' tradition.

Tsimane' swidden agriculture has diverse effects on vegetation regeneration, related to the size and shape of areas cleared, to the techniques of clearance and land use practiced. Regeneration throughout the period of fallow management changes species diversity, contributing to either subsistence farming or fallow regeneration. In addition, since hunting and fishing are parallel activities to swidden agriculture, secondary forest and fallow plants are felled for those activities. Therefore, regeneration of indigenous fallows is not only attributable to the factors controlling regeneration, but also to human management, which is the most salient factor in maintaining forest composition. The natural capacity of ecosystems to regenerate interacts with human actions and culture.

Fallow Plant Population

Taking into account the factors mentioned above that influence regenerating vegetation in fallows, the data for this chapter are derived primarily from two sources: interviews with informants and inventories obtained from the plot transects. Table 7.1 below shows the data organized from both sources.

TABLE 7.1 ESTIMATED PLANT POPULATIONS USING DIFFERENT TECHNIQUES

Techniques	No. Plots	Forest Plants	Cultivated plants	Total plants
Interviewed plant frequency	64	937	245	1185
Transects plant Frequency	24	8693	420	9113
Interviewed plant Individual	64	175	21	196
Transects plant Individual	24	381	18	399

To analyze the regrowth of plants, two techniques were used for identifying plants in fallows and plots. The interviews were conducted on site with all owners that were present in the community at the time of the site visit. Nineteen fallow owners were interviewed for a total of 64 plots. The total number of plants counted by respondents was 1,185. From those plants175 individuals were said to be not cultivated and 21individuals were cultivated, including agricultural cultigens. Transect inventories included 9,113 plants in 24 fallows, of which only 381 individuals were found to be uncultivated and 18 individuals were cultivated. The data show quantitative and qualitative differences depending on the data technique used. Although this has been completed with plants mentioned during the data validation with the three Tsimane' consultants.

To make the plant data easier to understand, plants are grouped according to the Tsimane' plant perception categories. Terms used are the most inclusive and attempt to show fallow plant categories:

Son are tree-like plants and may include any plant, depending on shape, structure, and hard tissue. The size of plant is not considered.

Cayaya, vine-like plants, includes any kind of vine, except those that grow from the soil attached to tree trunks.

Palm includes plants that look like a generic palm. Tsimane' do not have a grouping term for this type of plant, but use the Spanish term.

Shaba' shaba' are understory fern-like plants. Tsimane' distinguish those that grow attached to the tree trunks from other *shaba' shaba'* by adding *sonche.*

Paya are plants with small banana-type leaves, usually found along riversides.

Shuru' are plants that look like generic bamboo. This group does not include other bamboos that do not contain cane-hole materials.

Catedy*e* refers to all plants cultivated or planted, including non-agricultural, native, domesticated plants.

Coyoj are under-story plants that appear to be vines, but have very soft tissue.

Biruruc are plants that only look like grasses.

Vijyo are plants that look like straw.

Robodye are plants that grow on trees.

These terms are close to the English term, but not equivalent. In any case, this is only an approximation of the Tsimane' plant classification because there are other terms that group large and small plant categories as well.

Laboratory Plant Identification

Plants inventoried in Asunta's fallows were collected for laboratory identification. However, it was extremely difficult to collect all plants and identify them completely. All collected plants were identified in the laboratory of a National Herbarium of the University Mayor de San Andrés and the specimens remain in the plant collection of the herbarium.

A total of 550 individual fallow plants were recorded, of which only 399 were recorded at the transect sites. The other 151 plant individuals were identified during the confirmation of data with Tsimane' informants. The latter might not belong strictly to the fallows but scattered along the surrounding fallows. Of the over 400 plants collected, only 374 (68%) individual plants were able to be identified in the laboratory. Of these, 87 could only be identified at the family taxonomic level. Data obtained and described gives a general picture of fallow plot floristic composition.

TABLE 7.2 SCIENTIFIC IDENTIFICATION OF FALLOW PLANTS: ASUNTA

Plant Family	**Number of Family**	**Specie Variety**	**Indetermined**	**Transect < 20cm**	**Transect 20-150cm**	**Transect >15cm**	**Plant Sprout Interviewed**
Asclep.	3	0	3	0	11	7	0
Acanth.	1	1		0	1	0	0
Begon.	1	1		0	0	0	0
Bix.	1	1		0	0	1	8
Bromel.	1	1		0	2	0	0
Campan.	1	1		0	0	0	0
Cyclanth.	1	1		1	1	2	0
Cyp.	1	1		0	9	0	0
Dryopt.	1	1		0	24	0	0
Erythy.	1	1		0	0	0	0
Gesn.	1	1		0	0	0	0
Gnet.	1	1		0	3	0	0
Haemod.	1	1		0	0	0	8
Hernand.	1	1		0	0	0	0
Lecyth.	1	1		0	7	1	8
Lythr.	1	1		0	2	1	0
Myrsin.	1	1		6	56	22	11
Phytol.	1	1		0	0	1	9
Ros.	1	1		0	3	1	9
Sabiac.	1	1		0	0	6	0
Salic.	1	1		0	0	0	0
Selag.	1	1		21	396	66	10
Smilac.	1	1		0	2	5	11
Spind.	1	1		0	1	3	0
Til.	1	1		1	14	100	8
Verb.	1	1		0	1	0	0
Vit.	1	1		0	13	8	0
Conv.	2	1		1	6	1	7
Diosc.	2	1		2	2	0	8
Nyct.	2	1		0	0	1	0
Comm.	3	1		0	26	2	10
Anac.	2	2		1	19	19	12
Aral.	2	2		3	53	7	9
Caric.	2	2		0	3	12	7
Dillen.	2	2		1	23	26	18
Gram.	2	2		0	98	168	11
Malv.	2	2		0	0	0	0
Menisp.	2	2		0	3	4	4
Orch.	2	2	1	0	10	0	0
Rhamn.	2	2		0	7	4	0
Simar.	2	2		3	14	4	9
Theopr.	2	2		0	2	0	4
Viol.	2	2		0	11	6	4
Bign.	3	2	1	0	17	29	10
Borag.	3	2		0	20	19	7
Myrist.	3	2		0	7	9	18
Mus.	4	2		2	15	73	18

Hippocr.	6	2	2	0	9	4	10

Table 7.2 Continued

Combret.	3	3		0	28	11	17
Cuc.	3	3	1	1	10	11	10
Polygon.	3	3		0	11	24	18
Sapot.	3	3		1	15	37	11
Urt.	3	3		1	103	60	23
Zingib.	3	3		10	82	33	8
Sterc.	4	3		2	7	7	0
Burs.	5	3		1	13	16	9
Elaeoc.	5	3		3	26	17	4
Laur.	7	3	4	0	12	29	18
Chrysob.	4	4		3	6	2	0
Melast.	4	4		4	53	45	7
Monim.	4	4		1	27	22	13
Rut.	4	4		3	18	55	20
Bomb.	5	4		3	8	34	15
Leg. Caes.	6	4		0	3	3	10
Passifl.	6	4		0	20	19	11
Maranth.	7	4		0	266	66	25
Pter.	5	5		1	127	29	8
Solan.	6	5		2	126	147	32
Ulm.	6	5		4	12	15	36
Myrt.	7	5	1	1	14	6	17
Meliac.	10	5		0	37	47	49
Annon.	13	5	9	0	19	31	27
Guttif.	6	6		1	4	14	26
Apocyn.	6	6		0	56	13	0
Comp.	7	6		2	56	71	11
Pip.	7	6		116	714	460	11
Flac.	9	6	2	0	9	51	33
Arac.	7	7		0	7	2	8
Palm.	15	7	7	15	74	57	6
Leg. Mimos.	20	7	5	38	109	103	69
Sapind.	12	8	1	11	77	20	43
Leg. Pap.	17	8	7	0	39	20	53
Rub.	15	10	4	18	110	73	37
Euph.	14	12	2	5	73	115	81
Mor.	28	16	3	12	97	237	147
Caprif.	1		1	0	5	7	9
Leg.	3		3	0	4	4	12
Identified	374	261	57	301	3368	2625	1182
Non Identif.				131	1749	939	222
Total Freq.				432	5117	3564	1404
Plant Indiv.%							
Identified	374 (68%)			53	236	214	148 (84.5%)
Non-Ident.	176 (32%)			18	83	55	27 (15.5%)
Grand Total	550 (100%)			71	319	269	175 (100%)

The more common families occurring in fallows were: *Moroceae* (28), *Leg. Mimosoideae* (20), *Leg. Papilionoideae* (17), *Rutaceae* (15), *Palmae* (15), *Euphorbiaceae* (14), *Annonaceae* (13), *Sapindaceae* (12), and *Meliaceae* (10). However, the frequency of individuals was not always from the same family. For instance, *Piperaceae* counted in transects included 1,229 plants which belonged to seven *Piperaceae* plant families. Many of the plant families had fewer representatives than the nine indicated. Table 7.2 shows a relatively high frequency of plant families that are rich in the occurrence of plant individuals. Observing Table 7.2 and comparing the data from interviews and transects, the same plants tend to occur in fallows, which may indicate that those plants are more adapted to fallow conditions.

The 87 plant families are represented in 261 plants identified which stands for species diversity in Asunta fallows (See Appendix). This shows a great variety of existing plant species in fallows. Looking at plant individuals coming from transect, most of them are among the species found in which plants greater than 20 cm and 150cm are more diverse. To evaluate plant regeneration in fallows only 175 plant individuals were elicited for plant sprouting from the total of 399 plant individuals. The result 148 plant individuals from the of transects are sprouting in the field crops. At this point it might be important to compare with other studies. For instance, Gentry (1990) in summarizing the major families in 1-ha tree plots in Amazon indicates 20 plant families. Asunta's fallow contains almost all of these families except for one, *Vochysiaceae*. This first approximation to fallow vegetation composition by no means represents the complete data.

Fallow Regeneration

To explain the regeneration of the vegetation, differences between transects according to age of fallows were used. As a function of the methodology used in this study, I only present some aspects of the regeneration of plants in fallows within Tsimane' plant categories. The transect inventories are organized into three height categories using the recorded data and the plant categories: less than 20cm, 20cm to 150cm, and taller than 150cm. Table 7.3 gives an idea of the vegetative development in the areas managed by the Asunta community.

TABLE 7.3 REGENERATION OF PLANT INDIVIDUALS

Plant Categories	< 20cm	20 –150cm	> 150 cm
Son	37	181	177
Cayaya	18	61	43
Palm	4	10	6
Shaba'shaba'	3	7	5
Paya	2	9	8
Bamboo	0	5	5
Catedye	0	10	7
Coyoj	1	1	1
Biruruc	1	1	0
Vijyo	1	4	1
Robodye	1	5	3
N/I	3	16	7
Others	2	9	6
Total individuals present Total indv. Not present	73 326	319 80	269 130
Total Transects	399	399	399

For all transects, plants taller than 20cm tend to be more populous and diverse, and when they reach 150cm, they tend to show reduced vegetative growth and slightly lower diversity. Plants shorter than 20cm are less frequent in both quantity and diversity.

The implication of this fact is that height differences are associated with canopy growth and plant diversity is associated with composition of the plants. Both heigth and diversity of plants contribute to fallow forest structure formation.

The plant category *son* is more abundant than the other categories, which may indicate rapid vegetative regeneration of this type of trees. The *son* is followed by the *cayaya* (vines) and palm categories. Another interesting aspect is that plants taller than 20cm include a significant number of cultigens, which lowers gradually for taller than 150cm. However, the number of individual plants should not be confused with the occurrence of type of plants. For instance, *biruruc* appears one time as category, but in recent fallows *biruruc* individuals are abundant compared to other plants, and typically it disappears with overall plant growth.

To make plant regeneration on fallows clearer I quote an interview[4] from the most knowledgeable Tsimane'. Within the category of forest fallow they distinguish different stages of regrowth, which are recognized by *cum* categories and are associated with specific plant resources, as well as vegetation biomass, composition, and the dynamics of succession plants growing in the plot.

> *Cum' itsi' a'mo. Mo' cum parej farajeyac para yomodye aty dar cum tyi bun son. Judyeya vajpedye yomodye' quivij carijtaca aty dar mun Tsanaj mequi' mun judyeya parej para yomodye' carijtaca' aty dar atyu fe'tsacajsha' cum can. Jedye' cui momo son caveja aty dar mun aty sajreban' mo' can quivij cum can atyu' jam sajreban' aty dar mun Birina chime' cave tsun aty tupuj quijodyes Novei' chimedye aty dar aty jam Juju' Moco chimedye Shajquiba' chimedye. Aty dar quivij carijtaqui. Moya' yiris yomodye' moya' quivij jam bi' dar carijtac jam bi' dar mun son in* [Espiritu Canchi].
>
> Translation:

[4] Interviewed texts and myths are set in free translation throughout the chapters.

> Fallows do not have *amos*. Fallows after two years almost have big trees. After four years, it is ready for clearing again. The *tsanaj* grows fast and they are ready to cut again. [When searching for cropping plots], we look at trees and if they are thick it is ready. *Birina* also measures the fallow readiness. *Novei*, *juyo*, *moco* are also observed. Those are good indicators. If they are thick and bigger it is ready to clear again. After one year it is not good.

The text interview shows that the Tsimane' observes some plants and their characteristics as indicators of fallows that are ready to reuse. Plants like *tsanaj*, *birina*, *juyo*, *moco*, and *shajquiba* are probably the most common in fallows and the fastest growing plants. The biomass of these plants is observed and is taken into account when classifying fallows. The importance of the growth of vegetation in fallows depends on the type of plant biomass accumulated. According to the text the fallow in two years is already **monte** (closed by fallow vegetation) and by five years it is ready to cut again. Similar processes of vegetation recovery has been observed in Venezuela (Harris 1971). *Conuco* regenerates quickly. Fallows after two or three years are densely vegetated by woody trees and shrubs, and plants grow more than 5m height.

The Tsimane' people are able to explain the succession of plants in fallows. The interview said *biruruc*, *cocos* and *vishushu* disappear within two years but *pucuj* and *yacañi* do not disappear. After the second year *viruy*, *cavaquis*, and *na'me'* continue to grow. *Obeto'*, the *cayaya* plant, which was very abundant in the beginning, almost disappears, but some are left here and there. In the third year *cajñere'*, *cavaquis*, *na'fa'*, *virui'*, *pacaya*, and other plants all continue to grow. Those plants grow up to eight years. At year nine *cajñere'* begins to die while *batason*, *shayimo'*, *bitiru*, *shandyes*, and *pise're* continue to grow steadily and appear among the regenerated vegetation. By the tenth year, *cum* looks like the original forest. Changes reported by Tsimane' in plant species composition in fallows is important (Ewel 1986). These changes indicate a diversity in insect population, since every plant species tend to breed an associated insect species. This process may facilitate the reuse of fallows by the indigenous people.

Management of Fallows

Human manipulation of the forest for their benefit is as old as humanity. Paleobotanical research in New Guinea illustrates that humans have been manipulating plants since the late Pleistocene age (Wiersum 1997). This shows that many forest plants have been managed and used by local people, which may have resulted in transforming the original forest into an anthropogenic environment. The modified forest became a useful resource provider to local societies. Indigenous forest utilization and manipulation within local habitats evolved into relationships between nature and culture. In addition, purposeful manipulation of useful species does not necessarily result in an agricultural landscape, but may result in a manipulated landscape

To test how the Tsimane' manage fallow plants, questions were formulated regarding pruning and harvesting for each type of plant (Table 7.4). The result is organized by the age of fallows and in two broad plant categories, crop plants and forest plants, in order to observe which are the best managed. Pruning and harvesting are considered indicators of fallow management.

TABLE 7.4 FALLOW MANAGEMENT INDICATORS
(19 family plots observed)

	CROPPING PLANTS	FOREST PLANTS

Category	Years	No. Plots	Pruning Domest.	Pruning Semidomest.	Harvest	Pruning	Harvest
A	3-5	23	51	16	59	16	3
B	6-10	20	49	18	63	10	0
C	11-15	14	34	26	48	4	1
D	16-20	6	16	9	22	3	0
E	>20	1	1	1	2	0	0
Total		64	151	70	194	33	4
% Plants			12.74	5.90	16.37	2.78	0.33

1185 Plant frequency (100%)

Table 7.4 shows a pattern of management; the younger the fallow, the more managed the plot. Management techniques are high in fallows of 6 to 10 and 11 to 15 years, but management declines as fallows get older. In addition, management practices are highly oriented to cultivated plants and less to forest plants. Although the data do not show the specific plants managed, the semidomesticated plants include native cultivated plants, such as *väij* and *shuru'*.

Harvest refers to any type of collection, extraction, or harvesting of fallow products. It is assumed that people manage fallow plants for their needs and for fallow regeneration. Many cultivated plants (16.37%) are harvested while few forest plants (0.33%) are harvested. Plants that receive more care are constantly harvested. This is because fruiting plants can be harvested seasonally while forest plants that provide barks, leaves, resin and wood depends on plant maturation to be useful.

Considering the all the possible indicators of management, I minimized my study of indigenous management because I believe it is highly complex and involves the whole system of plant-soil- human interaction. To comprehend it fully probably will take more time in the field than was available to me. However, I would like to mention the term "synchronization" used by some agro-biologists to denote environment and plant growth knowledge. Tsimane' people know the appropriate time for felling trees, for planting and for harvesting and, because of that, they may get more benefits from the products. When asked ask why they do things in a particular way or time, the answer is almost always *jam jem*, meaning it is useless to do it any other way.

To summarize, the indigenous knowledge and management systems of fallows and vegetation, regeneration is not yet very well understood. However, I would like to outline some suggestions for further research. First, in fallows, the growth of vegetation is similar because cultivation is not always from border-to-border but rather in patches that allow vegetation to grow at different heights. For example, the Tsimane' combine *caij*, manioc and plantains, when planting which has to do with shade management, and the structure and composition of the plants. It would be interesting to explore these relationships. Second, the Tsimane' carefully observe weather changes when preparing, harvesting, and planting their plots. For example, the time of day is important for planting, such as in *väij* (peach palm). Research could determine these temporal rules and also why the lunar cycle is observed for harvesting and planting certain species. Third, studies could explore why the Tsimane' do not go to the forest or to their plots after a woman gives birth, why they do not have sexual relations before planting, and why they are so concerned about harmful odors of individuals.

These types of management factors are not very well documented or understood. However, it is believed among the Tsimane' that, to ensure long-term use of areas on swidden and to have optimum swidden fallow cycles, they must strictly observe these cultural domains in addition to physical management techniques in order to maintain productivity and conservation of the forest ecosystem.

Knowledge and Fallow Plant Use

In Asunta, as well as among other indigenous folk, knowledge and use of forest plants is complex and rich. To describe and analyze how this knowledge is related to fallow management I asked the households to describe the use of 175 plant individuals. This did not include agricultural plants. The questions, “Is this plant useful to you?” and “What is it useful for?” were formulated in the native language. Answers obtained have been recorded and codified in 8 indicators (See Table 7.5) that reflect the wide use of plants for different purposes.

TABLE 7.5 LOCAL PLANT USE AND KNOWLEDGE
(Interviews for 175 plants)

Plant Categories	Total Frequencies	Food for Humans	Food for Animals	Health	Local Tools	Wood	Construccion.	Fuel Wood	Other Uses
Son	471	116	219	50	66	35	78	415	35
Cayaya	43	7	10	24	0	0	0	14	7
Palm	16	7	14	1	1	0	10	4	1
Shaba’shaba’	1	0	0	0	0	0	0	1	0
Paya	16	0	7	0	0	0	1	0	10
Shuru’	11	0	0	0	3	0	2	2	7
Catedye	8	8	8	0	6	0	0	2	1
Coyoj	3	0	1	0	0	0	0	0	1
Biruruc	4	0	2	0	0	0	0	0	2
Vijyo	2	0	1	0	0	0	0	1	0
Robodye	0	0	0	0	0	0	0	0	0
N/I	3	0	1	2	0	2	2	3	0
Others	7	0	2	3	0	0	0	1	3
Total	586	138	264	80	76	37	93	433	64
%	100%	23.54	45.05	13.65	12.96	6.31	16.04	75.42	10.92

At first glance, almost all plants under the category of *son* are useful for energy and most of the plants are used for this purpose (75.42%). This is because Tsimane’ rely on the forest for fuelwood. The food indicators for human (23.54%) and animals

(45.05%) are another important fallow plant usage. Tsimane' people are able to describe parts of the plant in detail for different uses, like fruits, leaves, bark, and so on, and indicate their usefulness for humans and animals. One cannot imagine how these people observe the fish, the birds, and other animals of the forest to learn what they eat. The parts of the plants eaten by these animals are used as an indicator of the presence of animals around the specific plants or used as bait. The association between plants and animals permits them to keep and protect some plants. Some plants are preserved when scarce and cleared as useless when abundant.

The second category of plants used most commonly is *cayaya*. The stems of these plants are used for medicine and the fruits are used for food. In addition to these usages, some *cayaya* are used for *nutaqui,* to numb fish. I was not able to observe any ritual usage. From the data, *cayaya* usage is not shown properly, given that this type of plant is commonly used as rope. Tsimane', in daily life, use *cayaya* in different ways and for different purposes such as mooring canoes, attaching materials in construction, wrapping carrying bags, and binding *cajtafa* palm.

The use of palms is widely documented among tropical forest people. Tsimane' use indicates that palms are a source of food, handicrafts and construction materials. The Tsimane' make extensive use of three palms, *jajru*, *tyutyura* and *cajtafa*, which they protect but do not cultivate. The two former palms are collected seasonally and the latter is collected year round for roof repair and to sell to surrounding communities. Actually, the Tsimane' manage *cajtafa* palm and they recognize four varieties. The proper *cajtafa* is the finest and *yaraj yaraj*, *bojbori'*, and *iyaj iyaj* are the ordinary once. These palms reach 2 to 3m in height and are shade-adapted plants. Thus, this kind of species grows well in the understory of primary forest. When harvested it grows back in one year and Tsimane' of the Asunta do not use these areas for agricultural purposes. Most of these palms are rare in fallows, but in community areas they grow in abundance usually in the foothills. Other palms are considered as a source of food for animals and are rarely used for human consumption.

Paya is apparently not considered useful by many non-indigenous people, but the Tsimane' know it as a game animal food because of its soft leaves, soft stem, and soft roots. Tsimane' distinguish some 15 types of *paya* plants from other similar plants and *paya* leaves are in large demand. The leaves of some of these plants are differentiated by texture, size, and consistency. The Tsimane' use the *paya* leaves for cooking meat, like "aluminum foil", or for storage wrap, like plastic or wax paper in the modern world. Other plants of this type are used as medicine for animals and when found in the field are associated with the presence of animals in the forest. Yet others are appreciated because of their seeds, used for making necklaces. Those examples show wide use of *paya* for different purposes in the world of the Tsimane' forest.

Shuru', bamboo-like plants, include two widely known groups. The non-domesticated are mostly used for fencing and for making grills for roasting the meat of wild animals. The domesticated one is only used for making part of an arrow. However, for purposes of explanation, I include in this category other bamboos found in fallows. These bamboos have different uses, such as for making utensil for a *shocdye* sieve, for preparing instruments like knives or large arrowheads for hunting large animals, and for creating musical instruments like flutes. These bamboos are not included in the *shuru'* category among the Tsimane'. It is no exaggeration to say that to the Tsimane' people even the *biruruc* (grass) is useful. They know that animals like cows eat grass, but they also find the *biruruc* useful for making children's toys, such as small arrows.

Numbers reflect the quantity of plants used, but do not show anything about what is observed in daily life. In this regard, I want to give some examples of plants that have multiple uses. Knowledge about plants begins with plant identification, which requires the proper experience, skills and knowledge to use all of the senses in identifying plants. Every time I asked questions about plants, respondents first looked at the plant and observed its features. If it was not possible to identify it, they took some pieces of the plant, such as the bark, and observed the color of the resins, examined the thickness and texture of the bark, smelled them, tasted them, and sometimes, they waited a while to see how the sap of the plants was going to change in color. On other occasions they look at external features of the plant, such as the shape of the leaves, the color of the fruits and flowers, or the fine hair on leaves or stems, that gave them a clue in distinguishing the plants. They sometimes even observed the front and reverse side of the leaf for identifying the plant. These techniques are necessary because many plants have the same texture, height, or appearance, making identification difficult.

Knowledge of plants is linked to the presence of other plants and animals in the vicinity. They may be associated with non-human beings that protect trees and with some animals or insects that inhabit the plants, called *amo*. These aspects of Tsimane' knowledge are not easy to understand, but they help explain how the forest is perceived culturally and how it is used for making a living. To further illustrate Tsimane' plant knowledge, I will use some more examples of multipurpose plants that the Tsimane' recognize. In the category of *son*, the *conojoto* is the most respected and protected when found in crop plots. Although this kind of tree is considered to have spirits and is respected, during the dry period its resin is collected and used as fish poison in shallow waters. The appropriate time for collecting resin is when the plant loses its leaves, which only occurs in this particular plant. Walking in the forest one can observe the incisions on the tree. When it is felled in the crop plot, special skills are needed because, first, the plant master has to be dealt with and, second, because the resins may get into the eyes of the farmer and hurt them. In addition to fish poison, it is also used as medicine and repellent; when dried the trunk is used for making canoes, and the rest is used for fuel.

Regarding *cayaya,* the agricultural literature does not value it because of its characteristics and its capacity to sprout and invade the plot after clearing. During the fallow period, it may cause difficulty in the growth of trees. However, I found that these plants are a major source of food and medicine for humans and animals. The best example is *tiribu,* which is prized for food, medicine and fuel.

The local household goods made from forest sources are fascinating. Wood-like fibers from plants are used for construction materials of all kinds, including nails. For instance, Tsimane' use a variety of local materials consisting of tree trunks, palm leaves, and vines to construct houses. The *vujru*, a palm, is used as posts or poles to sustain or support the whole structure of the house because it resists rot in the humid environment. The roofs of houses are made from *cajtafa* palm, which grows in these areas and is in demand because it is clean, lasts long, and is easy to use for repairing roofs. Tsimane' people are experts in attaching *cajtafa* palm leaves. To join the pieces they use another material, a *tapij* (vine), which is widely used for house construction. Rope-like materials are obtained from a variety of vines and from some tree barks. These useful trees found in fallow are favored and when cut are taken to the community.

It is not evident, as among the Kayapo Indians that the Tsimane' old fields are important repositories of semidomesticated or manipulated plants. However, the intermediate fallows are rich in both cultigens and semidomesticated plants. Most Tsimane' fallows have patches with peach palm trees and *shuru'* (bamboo) and plots that are permanently managed. This does not imply that plants are not intentionally protected, planted or manipulated by Tsimane' people. They purposely keep certain plants and modify plant habitats to stimulate growth to take advantage of each part of the plant (Harris 1971, Posey 1985).

I did not find planted medicinal plants in fallows as in Kayapo's old fields (Posey 1985), but I did find native potatoes, fish numbing plants, and delicacies for children that are protected. Tsimane' would rather plant medicinal plants near their houses than in fallows. The location of not only medicinal plants, but also animal attractors, are very well known so they can be found when walking the trails. Old fields attract less wildlife than younger fallows. Game animals are particularly attracted to fruit trees, such as plantain and peach palm, so the Tsimane' usually leave them in fallows when small patches of plantain and pineapples are invaded by forest.

To conclude, what are the sources of Tsimane' knowledge? Ellis (1996) indicates *sobaqui* as a means of acquiring knowledge by observing their environment. This cultural practice, indeed, allows Tsimane' people to expand and socialize properly in the world while keeping their culture alive. The term not only applies to human social life, but to the surrounding environment as well. Tsimane' "traveling" does not mean only visiting family kin, but also includes all the observations made along the way. These experiences and remembrances are shared during the *sobaqui*. Historical events in a certain sense not only personalize the environment, but also bring memories. They are also associated with mythical beings that cause the landscape to work as "topographs" (Santos-Granero 1998). In addition, there is another more frequent cultural practice, drinking *shocdye*. During the week and after hunting Tsimane' people gather around the *shocdye* and talk about hunting, fishing and other activities. Tales, myths and other cultural codes are also shared seriously and through jokes. These two types of socio-cultural relationships enrich individual knowledge. In spite of these mechanisms, the knowledge of forest resources varies with age, sex, and social position. Older people can usually identify many forest plants and tend to also have a detailed knowledge of the ecology and reproductive biology of plants.

CHAPTER 8
SWIDDEN FALLOW SOIL FERTILITY AND MANAGEMENT

Introduction to Fallow Soils

Studies of tropical soils usually describe the relationship between farm productivity and the forest ecosystem, assuming that the natural vegetation is converted into an agricultural ecosystem. This conversion has been seen to endanger the natural forest (Norman et al. 1995). What is discussed less frequently than the natural and economic factor is the importance of human factor related to the types of agriculture that are not independent from those types of conversion.

In South America, as in other parts of the world, increasing deforestation has resulted in declining soil fertility, erosion, and loss of biodiversity (Norman et al. 1995). These problems involve knowledge of soil properties, management of soil in cultivated areas, and the techniques used in a production process. The techniques used are culturally modeled and implicate patterns of management used in a process of converting the natural forest eventually into other forms of land use. Certainly, edaphic factors have a place in plant development given that soils respond to the interaction of flora, fauna, and people. In fact, the fallow stage is one important factor in a succession that builds biomass. Thus, tropical soil not only develops under forest cover but also from organic matter accumulation that results from both natural processes and human forestry practices.

Many studies of swidden cultivation claim to focus on changing it into more productive forms, such as developing more intensive agriculture, creating appropriate technologies, and so on (Norman et al. 1995). However, productivity almost always means production for market trade. This definition of productivity depends on the different people being studied because productivity is not always focused on obtaining cash. Among the Tsimane', some crops are harvested partially or not at all. Further, the value of some crops may strictly be social or environmental. Productivity is not equal to all people, depending on degrees of acculturation.

Fallow agricultural ecosystems are built on human activities rather than on natural forest ecosystem dynamics. The tree canopies in a natural ecosystem keep the forest cooler, provide for a well-defined succession, maintain water quality, and influence the physical, chemical, and biological properties of soil. In contrast, food crop production alters soil properties and native vegetation composition in tropical forest. However, these alterations are temporary in indigenous swiddens because the forest rapidly regenerates and soil properties are maintained (Buol 1995).

Sanchez (1976) evokes human intervention and management as another factor that affects soil properties. Indigenous farmers possess practical knowledge related to soil properties. They are concerned with soil properties and landscape differentiation in which texture and other visible characteristics can be observed. Therefore, limiting factors observed over a long period of time must be coded into cultural priorities (Pawluk et al. 1982), although social, economic and political trends may endanger and even affect cultural cosmologies of soils.

Soil Indigenous Knowledge

The landscape of the study area, as mentioned before, is a mixture of low mountains, flat areas, and areas crossed by the Secure River, which originates in the mountains. The vegetation is Amazonian tropical forest characterized by high humidity and relatively low seasonal changes on temperature. Important forest reserves still remain in the area that might fall into evergreen forest, although the conversion of forest to cropland and back to forest is also part of indigenous fallow system.

The relative short-term land use in the community of Asunta is a form of cropland rotation. The practice involves one to three years of crop cultivation alternating with six to twenty years of forest regeneration. Tsimane', as in other tropical areas, utilize nutrients accumulated from several years of biomass growth that enhance native soil fertility for about one to three years (Sanchez et al. 1975). Moreover, the Tsimane' clear secondary forest which is not equivalent to primary forest in terms of biomass accumulation and probably not in the quality of nutrients released. Fire and natural decomposition are the mechanisms that release the nutrients that provide for the rapid growth of cultigens and vegetation regeneration.

Ethnically Tsimane' people distinguish physical formations into the following groups: *dara* (forest), *quejodye* (crop plot), *cum* (fallow), *ojñi* (water), *mocuya* (hill), *vaqmo* (plain), *jinaq* (small rivers) and *jamanche* (sandy). Cultivated areas fall within the physical space called *vaqmo* in which there are generic terms, like *quejodye* for cultivated areas and *cum* for fallow areas. Tsimane' farmers were asked about soil types in their plots. The Tsimane' farmers categorize the local soils quality on the basis of soil structure, texture and color. The classification of soils has been grouped into six categories, although there are other subcategories: *puijday* (fine sandy soil), *tsincas jac* (black soil), *jaibas jac* (white soil), *bojca* (mud), *jaman jac* (sandy soil), *pirij jac* (clay soil). From those categories the use of *puijdas* dominates local agricultural land use. The table below shows local Tsimane' soil use.

TABLE 8.1 TSIMANE' SOIL TERMS AND ASSOCIATED PLANTS

Tsimane' Soil Terms	English Translation	Associated Crop plants	Associated* Forest plants
Jaibas jac	white soil	manioc, maize, binca'	D, M, C
Jaibas bojca	white mud soil	sweet potato, manioc, binca'	S, T, V
Jaibas puijday	white sandy soil	manioc, binca', sweet potato	Sh, Mj, Shr
Jainas jac	red soil	sweet potato, binca' plantain	Cj, Mj
Bojca jainas	red mud soil	sugar cane, plantain, binca'	Vj
Puijday jainas	red sandy soil	manioc, binca', sweet potato	Mj, Co, M
Tsin'cas jac	black soil	peanut, plantain, sugar cane	Mj, Cj, Cy
Tsin'cas bojca	black mud soil	watermelon, banana, rice	Aj, B, Shr
Tsin'cas puijday	black sandy soil	manioc, sweet potato, binca'	Or, T
Tyuinus jac	brick-colored soil	manioc, sugar cane, binca'	C, M, D
Bojca tyuinus	brick-colored mud soil	sugar cane, maize, plantain	Cjt
Jaman jac	sandy soil	manioc, sweet potato, ajipa	A, Sh, C
Jaman bojca	sandy mud soil	binca, plantain, sweet potato	V, B,
Jaman jaibay	white sandy soil	manioc, sweet potato, ajipa,	B, V, Ts
Tyires jac	volcanic-like soil	plantain	Oj, Qr
Pirij jac	clay soil	rice, sugar cane, plantain	Cy
Pirij jainay	red clay soil	plantain, sugar cane	O

* Doto = D, Cajñere = C, Ajmo = Aj, Mu = M, Sejmeme = S, Tsana'= Ts, Vijyo = V, Cojma = Cj, Mujpe = Mj, Cotison = Co, Ororona = Or, Tyej = T, Arara' = A, Shoijno = Sh, Biruruc = B, Ojdo = O, Oveto'= O, Shara' = Shr, Cayaya= Cy, Conojoto = Cjt, Vijri = Vj

To understand the relationship between land use and soils type I asked the owners of fallows what type of soil was present in the plot. Based on their answers, a category of soil was defined and household members were asked what kinds of agricultural products and forest plants might grow or be associated with the soil category. The result of soil knowledge and the soil categories found actually defines cropping decisions regarding the use of types of soils and the kinds of cultigens to be cultivated.

Agricultural plants that tend to be cultivated and grow in soft sandy soils are tubers and plantains. Non-agricultural plants that grow in abundance in the same soils are the **ambaibo** and bush-like plants. Only one palm (*Ojdo*) was mentioned and several woody trees such as *Doto*, *Ajmo*, *Cojma*, *Mujpe* and *Cotison* were mentioned. My interest in looking at plants associated with soils was to see how the Tsimane' encode ecological information in naming landscape features, types of soils, crop and vegetation growth, and the coherence existing between indigenous knowledge and the physical and chemical analysis of soils. Further, the knowledge of both quality of soils and associated plant species growth allows Tsimane' to predict the specific agricultural plants to be cultivated and manage the soil appropriately according to the soil characteristics.

Fallow Soil Physical and Chemical Properties

The soil samples taken from the Asunta community were analyzed by the Insitituto de Ecología of Universidad Mayor de San Andrés. The results shown in this chapter belong to 24 replicated samples taken from 72 plots organized according to fallow age. The analysis considered physical soil properties, soil nutrient status (acidity, organic matter, calcium, phosphorous, potassium, magnesium, aluminum, and sodium), and quality of water from the Secure River.

The concept of dynamic or changing soil properties has profound significance to all ecological systems as well as for agroecology. Techniques for measuring and quantifying the impact of changes are time consuming and inevitably require long-term measurement to understand whole-ecosystem dynamics (Buol 1995). For the purpose of the present study and for the need of the Indigenous Organization (TIPNIS) the dynamics of Tsimane' indigenous fallow plots have been tested. It is assumed that when the natural forest ecosystem of the Isiboro-Secure National Park is subject to cultivation, the soil is changed by the impact of clearing, burning, cropping, and forest regeneration.

Most of the soils in the area according to ethnic classification belong to *puijday* (loam), which was verified by laboratory analysis. The soil textures identified fell into the categories of sandy loam and silt loam. The soils have low base saturation and are Ultisols and Entisols (USDA soil conservation service). They are highly leached. Entisols without pedogenic horizon are low in fertility because of the sandy soils. The area typically has been leached and has a lower capacity for water retention. As in other parts of Amazonian soils in the area may present deficiency on phosphorous and aluminum toxicity problems (Sanchez et al. 1975).

The Tsimane', burn after clearing the forest. Two or more weeks is thought to be enough time to dry the cut vegetation. In my observation I found they never reburn or practice the **picado system** in order to diminish reduce trunks and branch size for burning, although it is usual among the Mojeños. There is no concern if some areas in the plot do not burn well. The system of burning may fall to a “moderate system”

(Sanchez 1974) since this process may not cause changes in soil temperature. Further, I have not seen any changes to the soil surface, which might be explained because the soils are extremely humid. Rain falls almost daily in the area and if it does not rain, evapotranspiration is converted at night into a thick fog which supplies moisture. This fog is known in the area as **sereno** which occurs only early in the morning like the finest rain.

Soil surface structure is almost untouched although falling trees may compact it in some places. But if so, soon after felling the trunks are attacked by many bugs which restores the original levels of infiltration. Further, in fallows from 4 to 6 years old it is common to find larger trunks remaining that provide a continuous nutrient supply through gradual decomposition. Uhl et al. (1989) states that a distinctive feature of Amazonian cultivators is to crop without tilling the soil, which is also true for the Tsimane' of Asunta. Tillage is unknown in the area, although they use a machete or a small stick to remove enough soil to deposit seeds or cuttings in a new plot. Weeding also does not impact the soil because weeding is done by hand when the weeds are short and they are placed in the same spot, which also protects the soil from erosion. Neither surface crusting nor dryness occurs.

Runoff and erosion do not occur as much as in other areas in the Tsimane' agricultural fields of Asunta. This is because crop plots are small and the plots always remain covered by protective debris before and after burning. Moreover, there is no steep slope cultivation that may accelerate erosion. Records on the slopes of the crop fields (recent cleared and fallows) fall into three categories:

Flat land	0-3%	101 plots
Gently undulating	3-8%	4 plots

Moderately undulating	8-15%	3 plots

The Tsimane' cultivate in flat land areas and sandy soils. Flooded areas, steep sloping lands, and areas inhabited by leaf eating ants, **chaqas**, are not used for agricultural purposes. However, the characteristic of the soil in the Asunta area is very erodible. If it is cleared extensively and if other cultivation techniques are used, like those of colonists, they may greatly affect the physical properties of the soil in the Asunta area.

Fallow Soil Nutrient Evaluation

Tropical soils are generally considered to be acidic and low in nutrients, but as Peters and Neuenschwander (1998) state, swidden cultivation success has depended on fallow periods in which nutrients are accumulated almost to pre-cultivation levels. Further, various clearing methods result in different levels of soil pH. For instance, in an experimental situation, soil pH was reported higher in plots cleared by burning or by hand compared to mechanical clearance in area of Santa Cruz, Bolivia (Cordero 1964). Laboratory analysis of nutrients in both recently cleared and fallow plots show the following:

TABLE 8.2 pH AND Al CONTENT IN PLOTS CLEARED IN 1999

	River Side Plot*		Forest Plot North		Forest Plot South	
	Before Burning	After Burning	Before Burning	After Burning	Before Burning	After Burning
pH Rel. 1: 2.5	6.46	7.14	5.04	6.72	4.78	6.35
Al meq/100	0.06	ND	0.75	ND	1.53	ND

* ND = indetermined data

The average pH ranges from 4.78 to 7.14 in recently cleared plots, from strongly acid to neutral. In contrast, aluminum (Al) disappears in all three cases where pH increases after burning. On the other hand, the average of the two samples between all fallows differ:

TABLE 8.3 pH AND Al CONTENT IN SAMPLED FALLOWS

	1980	1982	1984	1987	1990	1994	1994	1995	1996
pH Rel. 1:2.5	5.18	5.81	4.6	6.07	4.48	4.76	4.70	4.33	7.56
Al meq/100g	0.34	0.10	1.56	0.02	1.96	1.27	2.19	3.22	ND

Recent fallows have a pH ranging from 4.33 to 7.56. They tend to be more strongly acidic than older fallows. However, the two plots in Table 8.3 that are quite high in pH (plots 1987 and 1996) might be explained by the agricultural histories of these plots. One plot (1987) consisted solely of bamboo and the other (1996) was only slightly cultivated after clearing, the rest of which was left to fallow. This particular management may explain their higher pH compared to other fallows. In turn, aluminum, one of the sources for soil acidity, is variable. This variability may be explained by plot management practices that modify acid soil conditions dominated by pH dependent charges (Brady 1974). Thus, for this study, where pH increases, aluminum is adsorbed and surface plot soils tend to be moderately acidic.

It can be concluded that pH increases after burning, after which it tends to decrease while in fallows. The pH levels still depend on above ground soil organic matter, and specific management practices may sustain or even increase pH, as shown in Hecht’s (1990) study of the Kayapo agricultural system in the Brazilian Amazon.

The essential elements for plant growth such as phosphorous (P), potassium (K), calcium (Ca), and magnesium (Mg) were also analyzed in Table 8.4.

TABLE 8.4 NUTRIENT CONTENT IN PLOTS CLEARED IN 1999

Nutrient	River Side Plot		Forest Plot North		Forest Plot South	
	Before Burning	After Burning	Before Burning	After Burning	Before Burning	After Burning
P mg/kg	6.73	16.74	3.97	33.96	6.88	23.39
K meq/kg	0.21	0.49	0.19	2.00	0.16	0.23
Ca meq/100g	23.99	31.05	2.99	6.97	3.24	7.64
Mg meq/100g	0.94	1.55	0.61	1.65	0.33	1.08

In all three cases, burning increases the amount of macronutrients. Nutrients such as K, Ca, and Mg, increased slightly, while P increased considerably. The increase of K, Ca and Mg after burning can be attributed to the partial conversion of above ground biomass nutrients into soluble form (Jordan 1989).

TABLE 8.5 NUTRIENT CONTENT AT DIFFERENT AGE OF FALLOWS

Nutrient	1980	1982	1984	1987	1990	1994	1994	1995	1996
P mg/kg	4.60	5.97	5.54	10.90	4.32	8.0	4.41	3.62	14.6
K meq/kg	0.52	0.13	0.21	0.29	0.16	0.11	0.23	0.22	0.14
Ca meq/100g	22.67	6.19	2.0	38.80	4.0	1.34	3.02	0.55	46.63
Mg meq/100g	1.68	0.82	0.44	1.69	0.74	0.20	0.67	0.27	0.42

By the time Tsimane' *quejodye* are left to fallow P levels are almost the same as pre-burning levels and in successive years tend to remain between 3.62 and 14.6 meq/kg, as demonstrated in Table 8.5. Where, K returns to pre-burning levels, Ca is highly variable. For instance, the1996 plot contains 46.63 meq/100g of Ca, which is superior to before and after burn data. Although Mg levels increase after burning, comparing these levels with the fallow levels shows that most of Mg return to the pre-burning levels, except in1980 and 1987, which maintain slightly higher post burn levels. Hölscher et al.

(1997) found a variation of nutrient contents in topsoils, suggesting that these levels could be associated with land use history of plots.

Nitrogen is one of the important macronutrients to the plant growth. However, only a small amount of this nutrient is found in tropical soils, most of which is in organic forms. Nitrogen is not directly available to the plants, although tropical plants may have developed efficient nitrogen cycling capacities. Therefore, soil organic matter plays an important role in relation to physical and chemical properties. Organic matter in the tropics accumulates rapidly and can be transformed by a range of living and non-living organisms that decompose and mineralize it for nutrient availability.

TABLE 8.6 N AND OM CONTENT IN PLOTS CLEARED IN 1999

Nitrogen and Organic matter	River Shore Plot		Forest Plot North		Forest Plot South	
	Before Burning	After Burning	Before Burning	After Burning	Before Burning	After Burning
N%	0.15	0.19	0.13	0.12	0.16	0.13
OM%	2.34	2.96	2.20	2.24	2.94	2.46

Nitrogen generally is low in tropical soils and volatilizes immediately after burning. The sample data taken from recently cleared plots in Asunta shows a slight increase of nitrogen in the river shore but some volatilization in the north and south forest plots. Changes in organic matter (OM) differ between the three areas sampled. The increases require explanation because OM usually tends to be reduced in high temperature burning. The increase of organic matter in the surface mineral soils can result from a high density of root plants, charred material and materials resistant to decompositions that may resist burning, or low intensity burning (“flush burning”) (Juo & Manu 1996).

OM holds organic nitrogen that is released by burning or by the process of mineralization. In Asunta, soil fertility and crop nitrogen demands may be increased and maintained by high rates of decomposition, inputs of crop residues, and on abundance of debris left in the plots during the first plot clearance which can be complemented by management techniques during the fallow period.

TABLE 8.7 N AND OM CONTENT FROM FALLOWS

Nitrogen and Organic Matter	1980	1982	1984	1987	1990	1994	1994	1995	1996
N%	0.21	0.11	0.13	0.28	0.14	0.19	0.12	0.16	0.14
OM%	3.77	1.86	2.0	5.5	2.41	2.96	1.92	2.46	2.85

In fallows there is no N accumulation and it appears that after cultivation it returns to the level of pre-burning. However, although variable, OM tends to increase in fallows. Management activities such as periodic pruning and clearing which is then left to decomposition (as in as in *väij* and bamboo cultivation), may aggregate nutrients. Based on the data collected, we can say that Asunta fallow rates of nutrient and organic matter accumulation on the top soil is similar to other tropical areas.

The nutrient content in managed fallows may significantly influence above ground material when compared to natural fall of leaf litter, which may also explain the variability of nutrients. However, clearing secondary regrowth in managed fallows prevents the mechanism of nutrient conservation within the plants. The result is that slashing limits nutrient accumulation in natural litter fall (Unruh 1990). To summarize, Jordan’s (1986) experimental findings support the changes occurring in Asunta agroecosystems. During cropping periods, nutrients (except for nitrogen) increase after burning, and even remain higher compared to the pre-cut forest. Further, it can also be assumed that during the period of cultivation nutrients in the crop and succession are low compared to the total amount in the ecosystem. Other remaining findings are arguable and do not seem true for Asunta.

The impact of cutting and burning cannot only be attributed to types of management and to specific ecosystems but also to the general types of ecosystems. For instance, eutrophic ecosystems lacking nutrient conservation mechanisms will store nutrients in soils, but oligotrophic ecosystems with lower soil nutrients developed mechanisms for nutrient conservation in biomass, which is released during the burning (Jordan 1989).

Also, evidence from Kembera, Indonesia supports the hypothesis that swidden agriculture does not degrade soil fertility (Kleinman et al. 1996). My study also supports that swidden agriculture is sustainable. This term, in a context of indigenous swidden agriculture, involves the capacity of resource management under specific cultural systems to satisfy human needs that enhances both quality of life and the environment. Conditions generated should be able to maintain, restore or improve resources used that, in the future, may be adapted to unexpected changes without endangering natural resources and cultural identities.

CHAPTER 9
FALLOW MANAGEMENT AND CULTURE

Oral Traditions and Swidden Fallow Management

Part of my interest in indigenous management of natural resources is to demonstrate that, as they are exposed to acculturation, indigenous forest-dwelling people need an explicit management plan that articulates with local and regional political systems that will not endanger the natural ecosystem. While there exists a rich oral tradition regarding forest resource management, I had hoped to find in my research some fixed community or family meetings, discussions and agreements that explicitly elaborated this management system. None currently exist.

There are many oral traditions regarding environment and natural resource use that help and direct the Tsimane' socio-cultural behavior in the community. Oral tradition certainly was the first method used to communicate knowledge and beliefs through many generations. There has always been sharing of myths, songs, stories, and social talk among the Tsimane' peoples. Cultural artifacts related to the varied circumstances and relationships between Tsimane' and their environment.

The Tsimane' believe that the environment was human-made a long time ago with great symbolic meaning. Reichel-Dolmatoff states (1975) that Indians are highly pragmatic thinkers but also abstract philosophers, builders of cosmic models, planners and moral designers. Amazonian indigenous myths such as those of Tukano Indians, recount that "the lands inhabited were originally peopled by their forefathers in ancient heroic times, and were handed on to their descendants as a solemn investiture in a perpetual trust" (Reichell-Dolmatoff 1975, 308). Tukano's creator was a son-father, who transformed himself into an anthropomorphic god to place plants and animals under the care of specific spirit-beings who can protect them and act as a guardian if nature is threatened.

On the other hand, Tukano's cosmological vision stresses "the continuity between nature and society", which is to say that all beings are considered within a human category. This conception has powerful consequences in human behavior, implying the need to treat other beings as "equals and persons". In this ideological framework indigenous populations do not declare "the supremacy of humankind over other life forms". Thus, Makuna social values, derived from cosmological conceptions is "to maintain the world" by emphasizing "man's responsibility toward the environment and the interdependence of nature and society" (Århem 1996, 201) which in a socio-economic context limits and regulates the human nature of exploitation.

The Tukano's world-view does not reflect humanity's place in nature in terms of dominion, or even describe environmental subordination, or life in a sense of "harmony with nature". Nature in their perception is not separated from humankind; thus indigenous people do not have to "confront the physical entity", "oppose it or harmonize" (Reichell-Dolmatoff 1975, 318) but rather coexist. The Makunas, who belong to the same linguistic group, believe that the nature is part of society and that indigenous people have a responsibility for nature because human beings rely on the maintenance of the environment and its resources. Both views stress the human concern for the relationship between nature and society in cultural representations.

Whether or not the myths and traditions are about actual events, they teach lessons about behavior, attitudes, and beliefs that cannot be acquired in daily observation or participation but only by communicating and listening. Passing knowledge from person to person includes criteria for ecological planning and the need for periodic reaffirmation and establishment of alliance rules between humans and guardians of nature. Thus, myths, songs, stories, and annual ritual are cultural reminders of the proper behavior between resource management and ecological balance.

No matter how people consider their relationship with their surrounding environment, "myth contains fundamental cultural concepts around which human society is organized" (Wright & Dirks, 1982, 160). Further, myth, besides providing the legitimacy for relationships, adaptive activities, and regulatory rules around resource use, is a function of the key code to maintaining the "cultural system within its own specific ecological boundaries" (Wright & Dirks, 1982, 161) which makes understandable human-nature interactions. Therefore, myths show that the biological and physical realities relate to subsistence priorities, in which the knowledge of seasonal availability of resources, geographical distribution, habitats and behaviors are involved.

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Tsimane' Cosmology

Dojity and Micha'

Given the general concepts of Amazonian myth and how different people perceive nature, I would like to briefly present the Tsimane' cosmological perspective from their own experience and their narratives. For this purpose it is important to understand the Tsimane' feeling about the deities of Dojity and Micha', and consider their creational activities. The power displayed by these gods may stand as a cultural background and reveal the relationship between individual and community daily life and their natural world.

The following translation is illustrative:

> The brothers Dojity and Micha' came down from the sky and created things. Dojity improved the earth by sending a woodpecker, which, by flying up and down, formed plains and mountains. Then Dojity and Micha' created people: The Tsimane' were formed from mud, white people from balsa wood, and black people from *yacani* – a hard, dark wood. After creating people, Dojity and Micha' were separated and began to go around the world looking for each other. And everywhere they went in their search for each other, they wound up also continuing to create and to teach people how to use their own resources. They created animals by turning certain people into certain kinds of animals. For example, a group of women were dyeing their clothing, which was made from tree bark, the color black. Dojity converted the women into howler monkeys, which are black to this day. On another occasion, Dojity, hunting with bow and arrow, shot a monkey. He then decided that people should also learn to hunt in order to be able to eat. To this day, the Tsimane' still hunt in the same way.
>
> Dojity tired of looking for his brother, so one day he asked the birds to help him and borrowed feathers in order to be able to fly. But he did not really pay attention to the instructions the birds gave him for singing as he flew, so the birds became angry with him and reclaimed their feathers. Dojity fell to earth, but as he fell the Vojshina tree quickly grew to help break his fall. This is the reason that the Vojshina tree grows very tall and thick. In order to get down from the tree, Dojity found a caterpillar to carry him down. Just before reaching the ground, Dojity pushed the caterpillar away, and the caterpillar's fall broke all of his spine. This is the reason that caterpillars inch along with their backs raising and lowering. Eventually, in search for his brother, Dojity reached a place where the earth and sky came together and he could not get through to reach his brother on the other side. He tried to hold the sky up with

> hardwood, but the hardwood would break. He then tried to hold up the sky with the wood of *arara'* and *ororona*, which are soft plants. The soft wood held up the sky, and Dojity was able to pass through. He found Micha', but then he robbed Micha' of one of his wives and ran away with her. Today both brothers live on opposite sides of the world.

The Tsimane' narrative highlights two cultural heroes: Dojity and Micha'. These mythical creators are believed by the Tsimane' to be the creators of the universe. Tsimane' cultural well-being is expressed through tales in which the heroes act as the main powerful deities. At the beginning they fill the world by transforming humans into animals and geographical features. Humanity was created from mud and wood, and because the earth was very soft and quite uniform, they transformed the earth into plains, land, and mountains so that the earth becomes more diverse. The time in which this happened constitutes the mythical times in which Dojity and Micha' manifested their powers (Sturzenegger 1986-87). In this myth time is always referred to by the term *uracyas* (ancient) in which successive catastrophes occurred.

The modern Tsimane' refer to *uracyas muntyi* (ancient people) as very bad people, so Dojity and Micha' had to create a new *muntyi* (people) whom they made from mud, and the modern Tsimane' feel that they are a part of that creation. Throughout the narrative the power of these heroes is manifested at each moment (Sturzenegger 1986-87). This mythical period of time is frequently referred to as a time of plentiful abundance on earth, in which everything was working automatically by itself and so work was not required (Antezana 1984).

Dojity and Micha' were powerful persons. They walked around the Tsimane' area and by transforming nature they brought order to the modern world. The events of nature transformation implicitly define the Tsimane' relationship to their natural and non-natural world. Thus, the narrative invokes the sacredness of place, gives shape and order to the world, sets the boundaries of the Tsimane' world, teaches people their proper place, and establishes standards of behavior.

One characteristic of non-human beings in Tsimane' myths is that they can change forms. This is why it is difficult to draw a line between people and animals in the myths. Among the Tsimane' not all humans have the spiritual power necessary to accomplish transformation, but the *cocojsi'* can acquire power only with the help and cooperation of non-human beings. This help is obtainable because people can communicate with other beings, and this can affect other actions. Plants and animals are people possessed by *amos* (protector beings) and are created by the same gods on the same earth that provides for the people. Thus, when a hunter talks to the guardian of animals, he asks them to come and then apologizes for killing them; the farmer talks to the guardian of the forest and then cuts down the tree.

Master of Trees: Amos

This cosmological order implies that everything in the world of the Tsimane' has a protector being and thus that the Tsimane' must communicate with all the inhabitants of the land. These protectors are called *Amos,* spiritual owners to which the Tsimane' have obligations in the same way that Tsimane' people have obligations to one another. Therefore, all activities such as agriculture are not only physical in nature but also involve other aspects such as communication, cooperation, and negotiations with supernatural powers. The appropriate relationship has to be observed to maintain one's place in the world, and disruptions may eventually endanger the farmer's life and affect the whole household or even the life of the community.

The Tsimane' sense of life and the productive system manifests the idea of a human/nature relationship governed by natural and supernatural powers in which there are no impersonal forces and all events are caused by someone else. The native people take care of their actions that are related to rewards, punishments, and potential sorcery that may result from the people and the *amos* relationship. For instance, trees regarded as big and tall are expected to have *amos*, as it is described. To illustrate this relationship the following text explains how the Tsimane' perceive the plant masters in the surrounding forest:

Translation:

> Since ancient times we have known that the trees we blew with tobacco smoke saying *cossa,* don't bewitch. *Bucuj* knows bewitch. His *amo* lives in roots and when we want to make *quijodye* we said "*cossa* don't bewitch me; go escape; don't get angry with me", we say. *Shejsherena, Bucuj, Vavaij, Conojoto, Yatyi, Vojshina*, they all know bewitch, they have *amos* but you have to say "do not bewitch; go away and do not get angry with me" and they go. However, they bewitch. In this case there is a *corpa*, which we use to cure.

The text indicates that human life is branded by non-human forces which inhabits the surrounding natural environment. Animals, fish and plants all have their own guardians and masters. The *Jajaba* is a master of all guardians, which in Tsimane' perception not only are the generators of life but also the withdrawers of human life. These beings are treated in terms of human relationships, what Ellis (1996) calls the "human social realm", because they control game animals. To be successful, humans are forced to maintain appropriate relationships with them. In the case of transgressions *Jajaba* may deprive game, bewitch humans and provoke illness and death.

In addition to the main master of nature, there are other beings of the forest. The guardian of a tree can exist in more than one being. For example, *sans*i and *unune* are comparable to human souls and *susunaqui* is the main guardian. The latter, *sususnaqui*, can be found only in bigger trees, usually in primary forests. It is believed that *sususnaqui* lives under tree roots or in bare holes that are, on the occasion of the cutting the tree, asked for forgiveness. When the Tsimane' say that they talk to plants, they mean that they understood and respected each other. They know that cultivation disturbs not only the forest but also the guardians. In order to produce their subsistence they do not see plants, woods or **monte** (type of forest) as merely a source of energy.

At one time, plants and animals were all persons in fellowship with one another. Ellis (1996) observed time spent in talking to the *amos* as if they were persons. That type of relationship between human and non-human avoids the predation of nature and prevents angering the *amos*. Words and forms of speech reveal much of the Tsimane' attitudes to the forest and they believe that they can communicate with and affect the spirits through rituals. The text reveals the importance of the relationship between spirituality and sustenance activities.

Since the natural resources are controlled by a keeper of spirits who could withdraw or make people's efforts useless, it is essential for people to prepare their spiritual power to talk to and follow the rules and ritual performances required for avoiding offending the keeper spirit. If the keeper spirit is not treated with respect, a person would be sure to suffer the disappearance of game and or cause a family member to be injured or become ill. Tsimane' has a word, *facoijdye*, or anger, which is applied to guardians. What makes guardians angry is not only inappropriate behavior or inadequate use of things, but also the odors of uncleanliness.

The Tsimane' daily routine always involves the need for material satisfaction, but also the fear being of bewitchined while obtaining food and other resources. It is a Tsimane' rule that one must act in accordance with the guardian beings of the forest at all times. Moreover, a reciprocal relationship becomes important in which tobacco and eggs are used for offerings. Even painted faces can serve as a sign of protection. This kind of relationship is common to Amazonian people such as in the Miraña and Huitoto indigenous (Garzón & Macuritofe 1990)

Among the Tsimane', a variety of forces and beings within the forest environment have the power to provide and remove the gifts of life and energy. This concept and its relevance to actual behavior have often not been accepted by outsiders. A clerk in the colonial period declared, referring to the Isiboro-Secure National Park, that he could not obtain transportation to the forest by the Indians. The Indians did not want to cut the bigger trees as the clerk wanted them to, because their guardian beings, so he had to demonstrate that trees do not have spirits and could not hurt anybody (Eder 1985). Attitudes of this type still continue among the missionaries and other non-indigenous people who want to wipe out the Indian's fear for the spirit of the trees. The Tsimane' people constantly negotiate their actions with the natural world so as not to offend guardian beings through odors and inappropriate behavior towards plants.

Cultural fallowing rules may highly influence plant fertility and regenerative potentials. The Tsimane' are greatly concerned with fallowing rules and maintaining appropriate behavior. However, Tsimane' attitudes are still poorly understood. A missionary living for many years among the Tsimane', recognizes and laments the animistic belief in "supernatural powers" that are extremely important to the Tsimane' and affect their daily lives. They live terrorized by permanent fear of sickness and death (Gil 1990). Because of the importance assigned to the forest guardians, Tsimane' are meticulous about acting properly among the human kin and forest guardians. Therefore, the discussion of these relationships during the *shocdye* drinking occasions is an important topic.

Tsimane' Song Trees: *Son si' A' mu' Jemaca*

Nature and culture are articulated through narratives and other cultural codes such as *jemaca* (song). Songs reflect the natural world surrounding Tsimane'. As Antezana (1984) states, their songs have to do with the manner in which Tsimane' articulate their social world. The songs are part of religious- mythic expressions in order pay attention to valuable resources within the society, production, and the world. On the one hand, it supposes an instrument of knowledge and on the other, it is a means for articulating the knowledge and the daily life concerns of the Tsimane'.

The songs control goods and their demand and distribution. The resources that nurture life and culture are placed or founded in myths and ritual songs or sayings, that have the purpose of sustaining their own society and protecting the environment from destruction (Antezana 1984). The ecological and cultural environment are aspects of the world that are manifested in some songs and on special occasions, as in the following song:

Son si' A'mu'	**Trees' Amo**
Cotison ca a' tumsi'	Guayaboche has its guardian soul (*amo*)
Porojma momo' yi nashu' (bis)	from ancient times, they know that plants have *amo*
Cotison ca a' tumsi'	Guayaboche has its *amo*
Vojshina ca a'tum mu'	Mapajo has its *amo*, too
Moya' Cabusha a' mo' mu', mu'	Truly plants have *amo*
Vojshinasi' (judyeya' cotisonsi') (bis)	Mapajo and Guayaboche have *amo*
Judyeya' mu' Shepi' mu'	Yellow garlic has *amo*
Moya' nashu', nashu' a'mu', jenej nashu	They have *amo*
Munty'mu', me nashu' bayi mu'.	And they live as humans do
Cotisonsi' judyeya' Vojshinasi'	Guayaboche and Mapajo
Judyeya' Shepi'si' mu', Shepi' judyeya' mu'	and Yellow garlic
Simasi', Simasi, nash chimedye	and Bibocillo have *amo*.
Moya' nashu a' mu' mu' jambi' nashu'quin	Truly they have *amo*
Mu' chiyac mu', mu' chatidye.	And still we know up to now
	They have *amo*, and they live as Tsimane'
Taca' ra' mu' chija' mu' a' mu' sonsi'	After all, we know that plants have *amo*
Moya' nashu', jayejdye' yojdye chija' tsun	we know they have *amo*
Moya' nash mu' chidye' mu cocojsi', Cocojsis tsun	because of the Shamans' knowledge
Taca' mu' mu' urucyaty se'vacseja', Yi in moya' catyu' A' mu' mu' son si', sonsi', sonsi', sonsi'mu'.	that trees have *amos*, *amos*, *amos*.

The text refers mostly to trees that grow large, which have *amos*, underlyied by the concept that all plants have their own guardian and master. They know from their forefathers that the masters and guardians live like humans, just like the Tsimane' people. This wise knowledge of plant spirits has been taught by the Tsimane' Shamans, *Cocojsi'*. This illustrates that Tsimane' are aware of guardian beings and have to treat them respectfully when they are using the forest. Moreover, each has to be considered as another *chatedye*, a term used to denote any other Tsimane', who is considered as a family member.

The climax of singing is at the feast of *O'ba*, which is a ritual occasion for success, hope, and conciliation between people and their gods. It is a feast where reciprocity is displayed among Shamans, common people, and masters and guardians of the forest. The event is held at the beginning of the season when flowering trees are in bloom, which may signify an appropriate time for knowledge and practices to be displayed. These are related to production and the maintenance of resources on which the social and cultural system relies.

This communication is essential for the spirits to facilitate hunting access to a kind of meat that is in great demand. Studies on the Tsimane' mention that the *cocojsi'* is an important person and that it is necessary to solicit and plead to the *amos* to obtain the animal by singing songs. The Tsimane' of Asunta say the *cocojsi'* uses tobacco for invoking animals and use songs to communicate with the game spirits. The scarcity of game animals today is attributed to the fact that the *cocojsi'* do not sing any more. They believe that the spirits are upset so they don't allow animals to be caught (Ellis & Velasco 1998; Perez Diez 1983).

It is at the beginning of the cycle, when the *yacañi* was flowering (known as hardest tree) or with the flowering *O'ba* (known as May flower) that *Cocojsi'* (Shaman) and Tsimane' people used to meet. This is probably a celebration feast because it is hunting season, which is also associated with the fatness of animals (Riester 1993). It is a joint event where society and nature meet. The song supposes a special social place where it is possible to experiment with the sacred and daily life. This allows the Tsimane' to look at themselves at a deeper level beyond mere entertainment song and social functions.

Tsimane' Myths about the Origin of Agriculture: *Opoj's* Fallow

There are several short myths regarding the origin of agricultural practices, which occurred in ancient times, most of them referring to manioc, tobacco, maize and cotton cultivation. The various versions have like elements such as emphasis on those cultigens for which human beings, and *uracyas* Tsimane' had difficulty getting seed for cultivation, but all of which were submitted to metamorphic changes under the power of deities. Among these narratives there are two traditional references that may be recognized as Tsimane' agricultural origins: the shape of the Tsimane' plot and the *Opoj* fallows left in surrounding mountains. The text on plot shape is as follows:

> We select a place and in that place a Tsimane' plants like arrows in the shape of circle. Then a strong wind comes and all trees in the circle are cut. A strong wind comes and chops the woods like arrows. They do not use an ax. After that they burn the plot, they throw a small stem of manioc and the manioc just starts to grow.

The narrative relates that in ancient times their ancestors knew that after selecting an agricultural plot they would have to mark the borders of the plot with arrows in the shape of a head. Once marked they just had to wait. Suddenly like a **surazo** comes the wind from the south and it fells trees within the circle in a moment. This reference is believed to explain why Tsimane' of Asunta still clear small plots in a circular shape. I observed that most indigenous farmers do not clear a circular plot but rather a square one, including Tsimane' studied by Peres Diez (1983), Piland (1991) and Rebecca (1996). The plot is cut and cleared by adult male labor, sometimes in collaboration with older sons (Perez Diez 1983). This pattern is changing with new features of settlement and outside contact. In Fatima, for example, they do not follow this pattern. They tend to fence plots and clear one square hectare. Even plants are becoming distributed in rows and square patterns.

This narration talks of the effects that natural disturbances have on forest. During the period of clearance, which occurs in winter season, there are surazos or strong winds that cause trees to fall. These natural phenomena open a small plot, which in ancient times might have been cultivated. Another reference is that in stormy seasons some trees are dried because of thunder, which also might have created small plots for planting since they did not have enough technology to open the forest at that time. Today those gaps are sought and visited. They may get fruit in them that they cannot reach from the forest floor and they always take advantage by making canoes if the wood is appropriate. These behaviors were observed as I went back and forth with the Tsimane' people to the forest.

The other narrative refers to *Opoj's* fallow, which still continues in some places in the mountains. According to Tsimane' belief system, agriculture is attributed to a mythical being, *Opoj*. Tsimane' talking about *cum* always refer to agricultural plots left in the forest by *Opoj*, recognized by the presence of plantain-like plants. In ancient times *Opoj* lived in the mountains near the Tsimane' settlement and apparently *Opoj* was the only one who knew how to cultivate a special plantain known as *pe're* in the Tsimane' language. The myth reads like this:

Translation:

> *Opoj* was an ugly man with a big nose who had some land. Once a pretty young girl dreamed about *Opoj*, and said to him in her dream that, if you are a man, you should bring me some meat. One night *Opoj* appeared for real and very handsome to the young girl. With the dawn, *Opoj* went to work on his land, and when the girl, now his wife, got up, she brought him his breakfast and some manioc beer. Not seeing him there, she called to him and left the food in the field for him. The girl left, and then *Opoj* came and ate the meal. This happened for a long time, and the girl never saw him. *Opoj* was a farmer, but he planted only plantains. The girl never lacked for plantains, and she wanted to see her husband by day as well, since she only saw him at night. So one day she brought *Opoj's* breakfast to the place where she could hear that he was at work with his machete. She called out to him, "I've brought your meal", and then hid in order to watch him come to eat. When he came out to get his food, she silently approached, and then called to him, "*Opoj*!" He looked up, and she saw that he was ugly. Then he said to her, "From now on you will suffer". He left his ax and disappeared into the forest. She never saw him again, and she always had to work hard to have her plantains.

The text shows that *Opoj* was a human being dedicated to his agricultural plot. His wife, a Tsimane' *nanas,* wondered why he did not show up during the day. One day she decided to go see him and while *Opoj* was eating his meal his wife appeared calling his name and she realized that he was ugly. *Opoj* went into the forest cursing the woman, making her work hard to produce plantains. In other versions people say that *Opoj* was the only man who knew how to cultivate the special plantains. Tsimane' people wished to have the plantains but when people asked *Opoj* how he grew them he always gave them another plantain, not the right one, so people never could produce them. The people became angry and decided to kill *Opoj* and have the plantains.

Perez Diez (1983) described this myth but he refers only to a second version that includes *tara'* (maize) as another cultigens produced by *Opoj*, which is hardly referred to in Asunta. Likewise he also relates a myth about *Mutun*, a wild turkey, that in his beak had a protuberance that looked like an axe, which is why it is said that *Opoj* transformed himself into a bird. However, other people say that *Mutun* was an agriculturalist and put his axe in his mouth; that is why this bird has an axe in its beak (Perez Diez 1983).

In addition to these traditions, there is another reference to agricultural origins. There was a tree, *puyu*, which was a man and used to work *quejondye*. He always worked the plot and stayed there. He did not want to go to his house, so Dojity flew by and transformed him into a tree to stay in a crop plot. Today these trees are found mostly in the crop plots. In addition to this tree there was also a *paya*, which was a woman. She was a wife of *puyu* and she did not want to go to her home either, so Dojity flew by again and she was converted into a plant, which still remains in the fields (Sturzenegger 1986-87). This may explain to Tsimane' why these kinds of plants are abundant in crop plots.

Fallows or open spots always have plantains in them and this plant is also found in other places, such as fields that have not been maintained for 15 to 20 years. Furthermore there are almost 15 varieties of plantains used as a staple in a multiple of ways. In addition, two types of *Opos pe're* were mentioned, one edible and the other not. To Tsimane' plantain is the primary staple, thus cultivation involves cultural as well as physical factors. For instance, the types of soil and quality of vegetation regrowth may indicate the fertility of the soil. Moreover, animal predation of cultivated plantains is not significant in the area.

Plant Myths and Beliefs: *Väij*, *Shuru'*, and *Ton*

The myths mentioned above describe the origin of agriculture and fallow. However, modern Tsimane' fallows not only contain agricultural cultigens but also plants domesticated by Tsimane' people. Those plants are very important to the Tsimane' and they have guardians but both are overlooked by conventional agriculture and researchers. Here, I will refer only refer to plants usually cultivated in larger amounts in the fallows: *väij*, *shuru'*, and *toñ*.

Väij

Translation:

> The flowering of the *väij* in September
>
> When the *väij* is not flowering, the plant, known as *O'pito's* wife, is pregnant. *O'pito* is the guardian spirit of the *väij*. When the flower opens, it is very fragrant, and its fragrance is a signal to *O'pito* that his wife has given birth. With the birth of the flowers, the war begins to determine which, among all the flowers, is *O'pito's* child. The war is fought with the thorns of the *väij*. When the war is begun, the Tsimane' women cannot go to the fields where the *väij* are planted, because their children might be bewitched by the plant's thorns.
>
> Harvest
>
> In the month of January, when the *väij* are ripening, the eldest man in the community begins the harvest. The oldest has to observe certain rituals for the harvest, for example, the day he begins the harvest, he does not comb his hair, and after the harvest, he does not have sexual relations with his wife. The night of the harvest, his family cannot cook, but the night following the harvest, he invites his relatives to an early meal, described below.
>
> Eating together
>
> They get together to eat around the fruits of the *väij*. The elder of the house peels the fruit with his hands, placing the peel in a gourd bowl and the seeds of the fruit are not eaten. The peel is not thrown away and seeds are not eaten because to do either would cause one's bottom to fall off. (!) The peeled fruit is divided into two pieces, and the man gives one half to his wife. Before she eats, she holds her earlobes, and pulls them, saying *Shiva, shiva, oyuj, oyuj* (parrot, parrot, monkey, monkey). Then, the mother gives fruit to her children, who repeat her gestures. The names of the monkey and parrot are called because the fruit of the *väij* will not make the parrot and the monkey sick, and thus calling them helps protect against disease or bewitching from the *väij*. The first harvested fruit needs to be shared, to further guard against bewitching by the *väij*. Sharing is important because eating the fruit causes one's soul to return to the place where it was born,

> where the mother left the placenta. The *väij* can grab the soul on the way, so it is protective to be with another soul who has also shared the first fruit. If there is no company in the house to share the fruit with, they will invite the household dog to share.
>
> Bath on the river
>
> After eating, the family goes to the river to bathe, carrying the peel and the seeds from the first fruit of the *väij*. They enter the water unclothed and, as they dive into the river headfirst, they toss the peel and seed into the water, saying "*Cossa*, that the river doesn't flood, that the *O'pito* doesn't bewitch us". Now, they are clean. On the following day, they continue the harvest and return to a normal eating routine. Other families then have to follow the same rituals, and begin their harvest in the same way, in order to avoid being bewitched. The rituals to ward off against the effects of *O'pito* continue into the planting, when planting must be done with eyes closed, or with two persons proceeding back to back, in the late afternoon. This helps guard against bewitching and also assures that the fruit will grow rapidly.

The *väij* (*Bactris gasipaes Kunth*), derived from the palm species, is the carbohydrate staple of many Amazonian Indians and peasants (Clement 1986). This plant is valued more than any other plant among the Tsimane' because of its multiple uses for hunting and dietary purposes. As a result, Tsimane' have an incredible knowledge of the life cycle and location of *väij*. These palms grow through their former agricultural areas and in the plots usually located in close proximity to the community settlement. Rather than simply harvesting them from agricultural plots, Tsimane' plant and exploit *väij* in a manner that supplies their long-term necessity through the fallows. The text above illustrates well how they appreciate and treat the peach palm.

As described, they are aware of all the stages of the vegetative cycle of the *väij*. They know that once the *väij* begins flowering that there is an *O'pito* (a non-human being) that cares for the plant, and that they have to follow certain rules in their relationship during this period. For instance, a woman with a little child is not allowed to go where *väij* grows. When *väij* is ripe, only the oldest man is allowed to begin the harvest, before which he has to accomplish certain ritual tasks. He cannot have sexual relations the day before harvesting or cook peach palm immediately after the harvest and he must share the cooked fruit.

The sharing of the first harvest as well as the manner in which the first harvest is consumed are both very important. Peeling by hand, carefully keeping the fruit peel and seed separate, and the use of gourd bowls show how this plant is treated in the cultural context. The ritual of eating *väij* connects life and death, the humanness and its spirit and their relation with other beings that may endanger their lives but also provide living resources. It is relevant to share the fruit so that one can feel protected. To close the first eating of *väij* produce, they take a bath unclothed and say ritual words to the water and *väij* seeds to make sure that the ritual has been completed. However, in the last part of the text, it shows that even planting *väij* requires a certain ritual behavior. The planting, harvesting, and eating *väij* goes through many rituals. In the literature, among the Makuna, this type of plant receives important attention. It is mentioned that the *väij* harvest marks the celebration of a fertility ritual during the rainy season (Århem 1993). Probably this ritual is initiating the crop and forest fruit harvest since there is another fertility ritual for the period of hunting animal. Thus, *väij* plant management is highly culturally bound; the nutritional needs and the risk of bewitchery interlock the human and non-human interactions.

Because of the importance of plants like *väij*, Tsimane' landscape and particular habitats are associated with specific plants which are distributed territorially over the entire community or in individual plots. The most significant in the Tsimane' swidden system is the concept of *cum* which provides food, preserves cultigens and thus receives careful attention. Cultigen preservation applies generally to fruit trees of various types, to *väij* clumps, bamboos, fruit trees, and large trees, which are suitable for building boats. Frequently when a person moves to another community or dies, the remaining plants in fallows are claimed by the nearest families who will care for and harvest them in the future. Thus, many fallows and their resources are a mechanism both for maintaining family ties and empowering the relationship between the past and present generation.

In addition to swidden agriculture, hunting and fishing are important activities that rely on plants cultivated in fallows for the fabrication of tools. The bow and arrow are fabricated by materials from materials grown in the fallows, especially *väij* palm and *shuru'* cane, which are carefully planted and tended. The bow is the main instrument for hunting and has to be made with special material like *väij*. Among the Tsimane', at least six varieties of the *väij* palm are known:

- *Väij* **propio** only for elaborating *shocdye*
- *Väij Acmadye* bigger and red in color is good for eating
- *Väij Ijshi're* red and small, good for *shocdye* and eating
- *Väij Cajsha'ma* medium yellow and good for eating
- *Väij Joijsi'* medium red edible for *shocdye* and used for bow
- *Väij Chomi'* looks like *väij* but not edible

There are other materials used in the construction of bow and arrow as well. There are other two small palms; one called *cajan* is used only for eating, and the other, *cojcope* is used for fabricating medium bows, the *petse* (lice comb), and blade-shaped arrows for bigger animals. The Tsimane' spend most of their leisure time making arrows, which requires great skill. Bird feathers have to be pasted in the right place on the bamboo like stick, the *panjmu ijmis* (bamboo stick) has to be straight to hit the animal, and the hard part (*petchjan)* protruding from the *väij* has to be sharp enough to penetrate the animal, which is called *fadaqajdyem*.

Further, *väij* serves for making *shocdye* and bait for fishing. That accomplishes the cycle of planting, hunting and drinking. Indeed, once plants are mature and bear fruit hunting weapons are made and once finished people may prepare for moving to hunting, fishing and gathering areas. They did not (*sobaqui*) wander aimlessly through the forest as they were supposed to by so many national officials, but rather had well-established principles of ranging area for seasonal resource harvesting and a system of resource management.

This Tsimane' concept of stewardship is encapsulated in fallow plots used for hunting and fishing (*väij* and *shuru'*), a concept that encompasses both a conservation ethic and a notion of resource ownership. To Tsimane', a *väij* palm is used first for its fruit and, when mature, for its trunk. When the *väij* is cut to make bows and arrows, the Tsimane' insure that the tree will coppice from the recently cut trunk. *Väij* is not climbing tree to gather fruit, rather harvesting by pulling and tearing the fruit pinnacle with a help of bamboo. On the other hand *shuru'* is not an edible plant, but rather is planted for material for making arrows. When harvested, the Tsimane' leave the smaller shoots so that they can grow to the proper size by the next year. Harvesting and managing these plants is public statement of ownership, indicating that the natural product belongs to them. The Tsimane' acknowledge this ownership as a family right that will be claimed through the generations.

Material from *väij* alone cannot make a complete arrow. In addition, some lightweight and straight material is needed, such as a bamboo flower stick, which allows the arrow to fly straight and far. To accomplish the size of the arrow a variety of bamboo called *shuru'* in Tsimane', is used. In addition, a hard bamboo also is used for the point on the arrows. The following text explain how these plants are treated:

> *Tsuntyi' viya' vun si jiquej isho'mun ca caij jiquej tascheche chij in ishonun si tsuntyi' jiquej viyan dye' jiquej in mun in chij vashi'shiraj uun in mu' in chij in me' ca ji quej oij catidye shiru' yi in jam ca quija jam ca nai', quija ca nai chata mo qui atyu dam' aty darj ye joi vashi chata' fets jetyebaj sha jam qui sani modye qui yejcoi' aj dar vei' ijmeij ijmedyes quin shiru'.*
>
> *Chime'dye' ton chimedye qui in chimedye mu' ton' chimedye me'dye' quity na'i' jamquity jam nai'j me' dye tsun tyi' viya' vun jiquej yi peyaqui urucya muntyi in raj shiru' ton chimedye'.*
>
> *Shuru' catedye co'shaij sa'ni. Jebeja jam jam' sani raj jam chipjan tyucseja' fetsja raj sa'ni jam jem chime'dye' ton' chimedye me', chime dye saqni chito' jam mo' me' chimedye' nutscheja jam (jebeja) ij raj joban tabedye' jam shu' qui jam jam cu' shac (jam caty co'shia' quijodye' mu')*

Translation:

> The *shuru'* is planted like *väij* at dawn. When some one is going to plant he must not comb his hairs nor touch fire; those are not good for *väij* and *shuru'*. When planting *shuru'*, one puts and takes out the *shuru'* root and then runs in different direction and then you put the roots back again. When *shuru'* is flourishing and it is harvested you must not whistle because it becomes wholeness and broken easily. It is not strong. After harvesting you do not have to roast the plantain because it ruins the *shuru'* and may dry the *shuru'* in the plot fallow. The same thing happens with *ton*.

A portion of the arrow is made with a very light cane derived from the flower branch of bamboo. The Tsimane' distinguish two categories of these plants, both of which are used for buildings and making hunting weapons: *shuru' abujre*, the common variety, is not planted and is used mostly for construction and smoking meat, while *shuru' catedye*, the finest type is planted in fallows and only used for making hunting weapons. The cultivated *shuru'* is diverse and there are ten types of this plant:

- *Shajbaty shuru'*
- *Namchaty shuru'*
- *Toro shuru'*
- *Dyufin shuru'*
- *Can'ches shuru'*
- *Tsivuty shuru'*
- *Tsivuty shiyij shuru'*
- *Ca'nam shuru'*
- *Shiyij shuru'*
- *Tsurivu' shuru'*

All these *shuru'* are cultivated in plots after harvesting the main crops. They vary in several ways. Some are very long, others short, slender, or thick. This allows one to make different sizes of arrows and arrows for different purposes. Two years after of planting, these plants can be harvested once a year during the rainy season. In February and March these plants are well maintained and well-managed because the people rely on this material for hunting and fishing.

There are other materials used when *väij* and *shuru'* are not available. *Na'I*, for instance, is a tree whose branches can substitute for the *shuru'* when *shuru'* are scarce or on long distance trips, when the provision of arrows has been exhausted. The tip of the arrow is made from different materials, which have to be sharpened and usually are heavy. These parts of the arrow are made from *väij*, *ojdo*, and *vijri*. There is also another bamboo-like plant cultivated, called *ton*. They distinguish fine and ordinary *ton* and this material is appropriate for making a blade-shaped arrow used for bigger animals like *shi'* (tapir), *itjtsiki* (jaguar), and *mujmñe'* (wild pig).

Other plants are used for hunting and fishing instruments, which may be protected even if they are not cultivated in fallows. The *Pocucus*, *Vajvason* and *Yacañi* are considered to have hardy woods and are used for various purposes. When used for hunting, they form special shapes because the hunter wants the prey to take alive. This type of arrow is called *comura* and has a small protuberance that does not hurt birds or snakes. These are also used for training domestic animals.

There are yet other plants used for making bows and arrows, some planted but most simply found in the first years of fallow. The *buma vajna* is a very fine vegetal tissue that is used for securing the feather on the bamboo and for making blades with bamboo. This string is obtained from several plants, but also from *väij* leaves called *väijsi shanmo*. The natural adhesives used for making parts of the arrow are also obtained from trees. The *musuruj* resin is the most commonly used, and often mixed with colorants called *puñi pamdye* that are derived from another tree fruit tree called *ta'* and *faj*. The material used to bend the bow rope like is also made from *quiruru* and *tyej* bark, which are harvested from fallows just in time, processed adequately for obtaining fiber and make a string of good quality.

In effect, myths show the hidden reality of the spirit-world (Århem 1996). Tsimane' cosmology shows that human and non-human beings, animals and plants interact and living the same world. Peach palm myth interlocks Tsimane' dependence on this plant for their survival and the beings that are related to this palm. Further, both *väij* and *shuru'* are important plants for making hunting and fishing instruments and they are the mainly cultivated plants in the Tsimane' fallows. The former contributes greatly to the material used for weapons and food. The second, besides its use in weapons, seems to play an important role in conserving nutrients in secondary successions. Rao &

Ramakrishnan (1989) indicate that bamboos in northeastern India contribute high levels of biomass and N, P and K.

The complex interactions and relations between humans and the environment are framed by cultural background to succeed in productive activities and for ecosystem conservation. The relationship is not simply confined to mythology and "supernatural beings", but includes daily needs for survival and both demands activities and carries threats. However, many people from outside consider these beings and myths to be prejudicial concepts that must be eradicated from the Tsimane' belief system. Certainly, any individual seeking a stable social existence and life, as Tsimane', perceives a threatening presence of danger: anger, illness and death. Anger is manifested as an illness that is invariably attributed to *farajtacsi* coming from supernatural beings in the form of sorcery (Ellis 1996, Descola 1994). But the perception and consequent behavior functions as an external protective power for balancing forest resource use and environment.

CHAPTER 10
RESEARCH DISCUSSION AND CONCLUSIONS

Fallow Research Discussion

Given that humans and their resources they use are intimately interwined, the need for cooperation between conservationists and social scientists is part of today's pragmatism in development. This study investigates Tsimane' indigenous agroecosystem from two different perspectives: ecology and culture. This framework was used to understand Tsimane' fallow management and to compare to some extent Tsimane' indigenous system with similar swidden cultivators in the Amazon.

I demonstrate throughout this dissertation that Tsimane' indigenous agroecosystems are ecologically, productively, and culturally intertwined. These results may raise the underlying coevolutionary aspects of culture and environment (Gliessman 1981). However, for the purposes of conservation strategy, it is important to document existing indigenous knowledge before addressing issues of this coevolution. Ecological and socio-cultural factors related to indigenous fallow management, such as Tsimane' rituals, should be the basis for analyzing and understanding their management and conservation practices.

Tsimane' Local Knowledge and Conservation

In this chapter I review Tsimane' knowledge as its relates to ecological principles. Then I make several recommendations for sustaining cultural practices that result in better conservation practices. I then summarize the theoretical contribution of this investigation.

The research design distinguished clearly between the bio-physical and human aspects of fallow management. This research shows that, in practice, both are highly intertwined. Natural features of Tsimane' environment include the forest, rivers, and mountains, but the importance of natural environment can scarcely be appreciated without understanding Tsimane' people. By living and experiencing the forest environment within this cultural context, one learns that rivers, mountains, and the forest are the matrix of Tsimane' life, around which environmental knowledge and cultural patterns have meaning. When traveling in the forest or along the river, the Tsimane' always know the exact location of resources related to game habitat, medicinal plants, salt licks, and aquatic resources. However, the landscape also serves as a mnemonic device to maintain historical and cultural information, to preserve and reproduce social relations, to locate and manage resources, and to interact with the spirits of the forest.

The physical environment establishes the rights of the Asunta Tsimane' community territory and for using and preserving the resources in the area. The Tsimane' people see the forest as a living network, in which imagination and experience produce a spirit that delineates the relationship between human and non-human beings. These contrasting relationships confront other visions of nature such as those of loggers, oil companies, and national development interests that will come to bear the immediate future.

Regarding the methodology used, several problems arose in identifying plants. The Tsimane' said the name of a plant, such as *tiribu,* and I recorded it as such. During the next field visit, I asked the names of plants again. Often, two or three plants are called by the same name, say tree, vine or palm. On other occasions I would identify a tree, say by the name of *joyo,* only to find out later that there are at least three types of *joyo* distinguished by the terms *miquis*, *istsuquis,* and *darjsi* - small, medium and large, respectively. Still other confusion occurs because biotic characteristics such as thorn and living insects, such as ants, are used in identification. They may call a plant *tayey*, the name of an ant that lives in that tree, but not the local name of the plant itself. One tree may also have more than one name, which one can hardly discover. They probably borrowed a name from some other language or developed names that reflect different uses. This is a problem of working with local languages. The other problem that I found is researchers always attempt to see indigenous fallow in terms of time, such as years. With Tsimane', standard western concept of time does not work, even in months or in terms of agricultural cycle. It would be better to use their cultural perception based on daily use. For instance, regarding fallows it seems important to ask in terms of Tsimane' fallow categories rather than years because they classify *cum* by observing the maturation of plants rather than by calculating years in fallows.

In spite of an extensive literature on swidden fallow agriculture and its relations with indigenous management, few researchers realize the implications of the term management, which connotes knowledge, from the academic point of view, specifically associated with tree reforestation. Wiersum (1997) suggests that forest management is the "application of scientific, economic and social principles to the administration and working of any area used for forestry for specific objectives". Management is equated with professional activities to manipulate the forest in order to produce timber and enhance the landscape. This background obfuscates the indigenous management system, which is not always oriented to the ecosystem, but rather to primary survival needs. Many studies show that indigenous management practices are directed toward forest resources. Indeed, indigenous management not only satisfies human needs but also cultural and religious needs, which involve different selective uses (ritual and non ritual) within culturally valued nature (Persoon & Wiersum, 1991).

Ecosystem fragility is an important criterion for resource conservation in many countries. However, in Bolivia this awareness exists in papers and in the agenda of everyday political spheres. Local non-indigenous authorities in the Isiboro-Secure National Park tend to modernize agriculture and introduce cattle. Although national officials tend to be in consonance with global concern for the environment and indigenous people, they allow oil companies to explore for petroleum and they plan to open a road through the park. The latter inevitability will open the area to colonists and loggers. How does one make conservation practices between different groups with different interests compatible? Impoverishment and deforestation are already occurring on the main lands of the Tsimane' and surrounding areas of the Isiboro-Secure National Park. To correct this problem, new strategies from interdisciplinary perspectives are needed to protect and conserve the Isiboro-Secure National Park. The results of this study deepen our knowledge of Tsimane' fallow management systems, and is the basis for an environmental educational program which both satisfies immediate production demands and which at the same time reinforces and maintains the indigneous culture.

In spite of technological advances, there are only a few cereals (maize, rice and wheat) that support the vast majority of global caloric needs. The green revolution, the pride of modern agriculture, did not eliminate environmental risks. Rather, it endangered traditional agriculture by expanding monoculture and it is not immune to climatic changes and diseases. In this sense, indigenous fallows may offer other alternatives. They offer foods that are cultivated and consumed by native people. For instance, among the Tsimane' there are some tubers and fruits that are usually ignored by agronomists and development projects (Norheim 1996)[5]. Tubers are mostly found on fallows and the fruits in any surrounding forest. Table 7.5 on plant use shows that most plant parts can be consumed by humans, animals, birds, and fish. Non-indigenous local people scarcely appreciate these plants as a food source because they consider them as part of the wilderness domain.

Fallow and forests plants used by Tsimane' may be important as protein sources for humans and animals, and certain plants may supply nitrogen. Moreover, Tsimane' *cums* may create guidelines for resource management in the Isiboro-Secure National Park and for designing conservation strategies. Plants like *väij* among the Mojeños are not cultivated anymore. Likewise, *shuru'* and other plants might be encouraged and disseminated for use by artisans.

Along with crops, trees are planted that can mature at different times during the fallow which may benefit the agriculturalist continually. Some contend that trees, timber such as mahogany (Unruh 1990), and fruit trees should receive major attention. With regard to these hopes, I would say that this type of attitude does not develop spontaneously unless there are changes in cultural patterns through market motivation. In Asunta, as in other places, Tsimane' have been in touch sporadically with loggers and they know that they ask them to show them where to find the most desired timber trees, so they learned that trees can be converted to cash. Only through this motivation do most indigenous people today tend to plant mahogany. For instance, one Tsimane' in Asunta has one hundred or more in plots and in surrounding areas. Certainly, it is true that after harvesting crops the swidden is cultivated especially with perennial crops such as pineapple and plantain, which are interspersed among annual crops (Unruh 1990). However, this does not mean that fallow has become agroforestry. The transformation of fallows acording to agroforestry models is a development that is in the peasants' interest, but not in the interest of the Tsimane' indigenous people.

Among the Tsimane' the *cum* are cultivated with many varieties of cultigens as discussed in chapter six, some of them shade tolerant such as pineapple. The number of forest tree species (cultivated and non-cultivated) and agricultural crops found in *cum* are diverse. The management of Tsimane's fallow is to provide for their necessities on the basis on forest knowledge, which to some extent diversifies the natural ecosystem also. Mixed cropping optimizes the use of nutrients and the combination of different heights of crops favor vegetative growth similar to that in the forest. Thus the *cum* is the main land use among the Tsimane' and some use of plants in fallows may become an alternative to other land use strategies. Knowledge is age and gender related. Everyone has

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[5] Development Tsimane' Project Report indicates that idigenous people were amused regarding potato

knowledge, including children. However, among the Tsimane' there are differences between knowledge among men and women. Men tend to know more about trees and plants, but women know more uses for every plant. Knowledge cannot be acquired at one time; it comes with necessity and circumstance.

The land in Asunta, which is acidic and nutrient deficient with low fertility and dependent on forest cover, can be unstable, making recovery after disturbances difficult. In Isiboro-Secure, scale disturbances are not significant according to Godoy (1998). Mojeño clear one hectare, Yuracare 0.81 ha and Tsimane' 0.52 ha from both primary and secondary forest. In contrast, colonists on the border of Isiboro-Secure National Park are the most extensive and intensive land users. In comparison to these agriculturalists, Tsimane' of the Asunta do not cultivate extensively or intensively, so they may not affect soil properties. The two types of fallows, one left to natural regeneration and the other still used with pineapple, *väij* and *shuru'* plantations, may play different roles regarding physical and chemical properties of the soil. Use of the secondary forest alternates with use of primary forest, because Tsimane' reuse fallows after some five years so that they do not cut the primary forest. The size of Tsimane' plot also influences conservation because the early succession species colonize small plots and the surrounding forests rapidly contribute to diverse plant regeneration. This type of management has little negative effect on plant biological diversity and reproduces the architectural features of a primary forest. This process may also regenerate desirable soil properties.

Myths and rituals are not enough to define the relationship between humans and their environment. There must be some practical rules expressed in daily life that

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introduction from Cochabamba because they have many satisfactory tubers already.

effectively regulate the destruction of natural resources. Studies in the Amazon in this respect are similar and show that indigenous people framed their population under the concept of regulatory mechanisms of resource use.

Population growth is one of the concerns raised by ecologists and environmentalists as factors affecting nature. However, this has not only been an issue for modern scientists, but also for indigenous people. Birth rate regulation customs among native people are common to all indigenous peoples in the Amazon region. The Tsimane', as the Tukano, have practiced a number of "oral contraceptives and sexual continence" (Reichel-Dolmatoff 1975) in relation to almost every type of activity. Among the Tukano women the use of herbs for temporary sterility is documented. This practice somehow relatively spaces the births. Among the Tsimane', every household has in their garden plants related to childbirth and menstruation regulation. They, like the Tukano women, know some seeds that have the purpose of spacing childbirth.

What are the implications of these attitudes? Sociocultural norms function as a regulating mechanism between nature and the Tsimane' people. At certain times they are not allowed to eat certain fruits, fish or animals because doing so they may endanger themselves or the community. Therefore, people's behavior may balance the relationship between nature and population increase. But what could happen when these people gain access to health centers? Will they maintain their traditional knowledge and balance nature and populations? Degradation of the environment may occur unless educational and development programs incorporate their cultural perspectives regarding population and the environment.

Another cultural aspect that plays a role in conserving resources is the perception of disease. Tukanos as well as other native people think that illness is caused by specific agents. First, it may due to animals being killed as revenge or punishment by guardian spirits. Second, their partner may provoke illness by witchcraft. Third, non-human beings may endanger people (masters of animals or plants). In this context, although illness is interpreted as a transgression of cultural norms, the disturbance is attributed to inadequate behavior regarding the environment (Reichell-Dolmatof 1976). When Tsimane' get sick they try to find out through rituals who or what is the probable cause of the illness. They usually find some spirit of the stones, rivers, trees, and so on as the cause. I saw one case where a child got sick and the people found out that the place where he was making the *quejondye* was *faqoydye*. As a result the family abandoned the plot and did not work. In this case, the notion of "forest spirits" functions as a protective device because this place will be preserved and never worked.

In effect, together with management practices, cultural perception reinforces attitudes regarding the environment. However today, educational centers and missionaries, both Catholic and Protestants, teach people how to free themselves from spirits and even demonstrate that nature is not harmful. Indigenous people face a battle between their perception and outsider perceptions of nature. Although some say laws should be enacted to help to regulate the relationship between nature and humans, I believe laws must not be made only for indigenous people, but for all of us.

Recommendations

The research on Tsimane' swidden fallow showed a wide experience in plant knowledge, management, utilization and traditions. A complete understanding is necessary and it has to be investigated under different topics. Within the TIPNIS the research should be conducted for all three groups regarding agriculture which may allow us to compare the similarities, differences, and potentials of swidden and fallow management.

Swidden fallows in the TIPNIS have various ecological zones that stand for different physical and biological conditions. Thus, the impacts and dynamics will be different related to management which also needs to be studied. For example, in the seasonally flooded areas people build mounds for planting manioc, and in other areas with scarce land cultivation, they manage areas called islands; these areas are different from the Tsimane' area, but still indigenous people from the TIPNIS practice swidden cultivations. Here, soils, plants, cropping system as well as fallow management will differ among the groups. The research on this topic has to be encouraged for understanding the diverse use of local resources.

From a cultural perspective the study showed a rich oral tradition regarding fallow plants and the nature in general. This opens different aspects of knowledge and illustrates how people interact with the nature. This mostly occurs with plants but also with animals and other resources. Further, the cultural background in a daily life regulates between peoples' behavior and the nature. This is another field that has to be explored with more detail: looking at the interaction of indigenous people with fallows and community activities to see how cultural patterns direct peoples' behavior.

Richness in species diversity of plant fallows requires a complete botanical identification. The plant categories found for different uses among the Tsimane' have to be determined in terms of quality and quantity, especially plants related to medicine, food, and timber. The study may enhance nutritional, agronomic, and economic valued species.

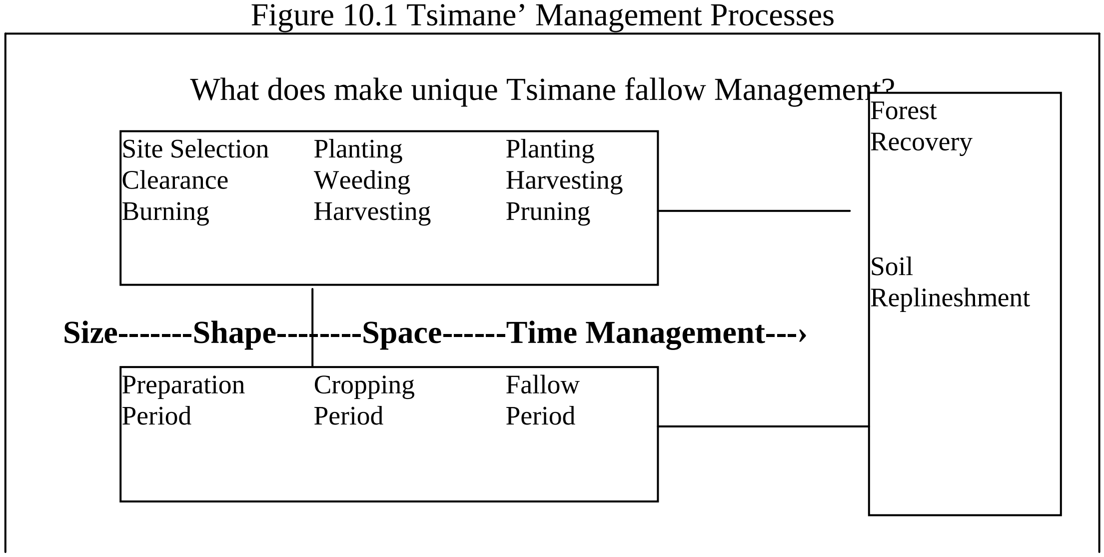
Agriculture land use is important for all three groups and the management of plants such as peach palm and bamboos may be regarded as biological enrichment. These need to be tested and studied more deeply to value their effects on fallow soil and vegetation. Further, in managed fallows, succession described by the Tsimane' need plant identification by plant biomass and nutrient builder which may allow to reuse the fallow in a short period

Finally, in the Isiboro-Secure National Park it would be interesting to begin to value oral tradition related to environmental conservation and apply to TIPNIS management. The three indigenous groups living there have different strong traditions, and every group is attached to their belief, although some have been influenced by missionaries. The research requires an applied anthropology strategy for developing research and educational programs. The programs have to be based on their language and tradition in order to incorporate their cultural perspectives.

Conclusion

Attempts to eliminate swidden from the world agricultural system it is a serious threat to the very survival of indigenous people. Eliminating indignenous technology excludes a source of knowledge and encourages an end to authentic agricultural understanding. More importantly, the elimination of swidden agriculture will destroy native rationality of forest management. Among the Tsimane' of Asunta swidden agriculture does not result in deforestation and the use of native technology and management systems are adapted to a local physiography and environment. Minimal clearance, exposure to the light, plants adaptation and weed management occur, but all of these are beneficial to the environment and to the Tsimane' swidden cultivation. The Fig 10.1 below summarizes the dynamic of the Tsimane' swidden fallow that illustrates the cycle of forest swidden management and the effect of that cycle both above and below ground level.

Figure 10.1 Tsimane' Management Processes



Tsimane' swidden fallow management is a conversion of both primary and secondary forest that begins with a period of preparation, a short period of cropping and a relatively long term fallow. The study of fallows in Asunta shows the plot changes from a successive management in which size, shape, space and time are important for forest regeneration and soil replenishment. There are two lines of fallow: one permanently managed and the other left only to vegetation regenerations. The management of fallow serves for food security source, for providing material for hunting and fishing, and for replenishing the ecosystem by means of selective cutting, plant regrowth and allowing patches of plot for plant sprouting.

Tsimane' fallows do not tend to agro forestry system but most of the fallows have one or two peach palms and bamboo patches that may have several functions such as biological enricher of fallows and seed disperser attractors. Fallows are not abandoned because of harvestable resources and hunting possibilities. Tsimane' recognize important successional plant fallows which indicate the phases of fallow for new cycle. Once mature within the Tsimane' fallow categories the fallow will be reused. The swidden fallow of Tsimane' traditional management and methods they use allows secondary vegetation regrowths. Tsimane' swidden is not destructive, but appropriate in a current situation.

Knowledge and research presented supports the complexity of indigenous knowledge on fallow management and techniques that they use as in other Amazonian groups. Research cannot reduce the indigenous knowledge to a list of concepts and ignore the traditions that involve perceptions, experience and cultural practices. Cultural patterns that regulate interactions of people, plants and nature are effective in daily life.

Research on the knowledge and cultural concepts involved in human activities requires an interdisciplinary approach. Any artifact on which humans rely for their survival has myths, stories, and other cultural clues. The Tsimanes' cultural artifacts that can supports their cultural foundation for their bases of existence, preserve the history of traditions related the needs and management and conservation have not yet been studied appropriately.

This study provides evidence that supports the hypothesis that the Tsimane' swidden-fallow agricultural system is sustainable and promotes regeneration and diversity of forest vegetation in the Amazonian regions of South America. It has been demonstrated that these systems are based on accumulated knowledge about the maturation cycles of plants and trees, and how these cycles fit into cultivated ecosystems, combined with a belief in guardian spirits of the forest that must be respected.

Clearing techniques such as cutting and pruning and leaving patches without cultivating are important to Tsimane' fallow management. Debris left after cutting through fallow, and refraining from use of fire to clear the fallow are also part of the management system. Harvesting at the proper time is also part the of management system and important to both domesticated and semidomesticated plants. The clearing of primary and secondary forest is balanced. The Tsimane' do not cut more that one plot from the primary and secondary forest. Those that are cut and cleared are not regularly adjacent to each other, which protects them from a breakout of weeds and changes in vegetation. After 25 years, fallow plots are similar to natural forests, which is a testament to the sustainability of swidden-fallow management techniques.

Cropping for a short period and followed by fallowing is the basis of land use among the Tsimane'. The characteristics of swidden fallows are that the area of clearance is small, shapes of plots tend to be circular and are never in straight lines, and patches are not subject to complete cleanliness, which is an aid to reforestation. After harvesting the main crop the land is followed and managed, especially young fallows. The older the fallow, the less managed it is, and there is no fallow after 25 years unless cropping has resulted in failure and then it may no longer be considered fallow. Fallow reuse is common, beginning at about five years, the time being determined when some plants have attained certain biotic characteristics. Plots in transition to fallow are planted with plantain, *väij*, *shuru'* and pineapple and are managed regularly as opposed to those not cultivated.

Four categories of fallows have been found in which 11 categories of plants are regrown. Looking at the height of plants, growing to heights of between 20 and150cm tends to be more common. Weeds are controlled by natural growth of vegetation, although when crops are growing only cropping sites are weeded before the plant seed. Management technique applied to younger fallow apply to peach palm, *shuru'*, pineapple and plantain and occasionally to fruit trees.

The amount of land cleared by Asunta Tsimane' is not significant. In 1998 only 0.33 hectares per household were cleared, which enabled to Tsiname' to colonize vegetation faster than in more open fields. Further, surrounding vegetation is a mix of primary and secondary forest, which contributes to regeneration by dispersing seeds to human-disturbed plots. Regeneration begins after clearing because Tsimane' do not burn the entire plot, illustrated by the comparison of patches both cultivated and non-cultivated.

The Tsimane' burning system does not damage root masses and stumps in the cultivated areas, and also, there is no attempt to discard or eliminate debris from the plots. Some plants left in the plot contribute to regeneration and even more, protected fruit plants attract dispersers of seeds to the disturbed plots. The Tsimane' like more fallow for peach palm, *shuru'*, and plantains. However, there are other small plants that remain in plots as a repository of seeds and they are adapted to the forest like-environment. Those, such as *binca'* do not need permanent maintenance.

The Tsimane' know how succession occurs in fallow, although this topic has not been deeply investigated. A suggestion for further research would be to study how the Tsimane' understand the succession of fallows. Knowledge of maturation of every plant, including what plant dies and what plants persist should be studied.

Soils of the Asunta fallows are acid and sandy. Burning affects nutrients and changes are not significant regarding N and OM of soil. Nutrients like pH, P, K, and Ca increases but Al is reduced. Fallows in Asunta as in other studies tend to be lower in nutrients after cropping. The data shows patterns that are similar to tropical soil studies in other Amazonian regions.

Tsimane' knowledge is complex, profound, and diverse. This research study, from beginning of listing plants for quantifying to the detailed description of plant parts and techniques of identification demonstrates the knowledge that Tsimane' have and their ability to manage the stock of knowledge. They have specific terms to distinguish plant categories, their uses and places where they are likely grow. Knowledge and management is interlocked and both are not isolated from their cultural universe. The abundance of myths, storytelling, and cultural practices shows that most of Tsimane' management practices are based on their culture. These are manifested in the acknowledgement of non-human spirit beings which regulate the relationship between nature and Tsimane' people.

Fallow management should therefore be considered to involve not only production practices, but also all conscious human activities directed to maintaining agricultural ecosystem capacity. It is a process of implementing and deciding the use and maintenance of fallow resources and organization of activities around the entire cycle of agriculture. The Tsimane' main agent of fallows includes the technical and cultural arrangements involved in the protection and enrichment of the forest resources for the immediate and future needs. Thus, Tsimane' indigenous management is a process of making decisions and displaying actions by using forest resources within a local territory. The activities displayed are based on sociocultural experience, human-environment interactions, common interest in the community, and shared values.

The Isiboro-Secure National Park contains a variety of communities as regards linguistic, socio economic, and cultural differences. The human factor in areas with ecological interest is critical for conservation, even more so, if development programs are to successfully implemented. In such a situation, management concepts derived from traditional knowledge and fallow succession may make sense for conservation. In applying the values of fallow management and its relationship to conservation in local resource use, we have to recognize that conservation strategies are needed not only in the park but also in buffer zones around the park. Protection of buffer zones may have intense biotic impact, since swidden agriculture, wild life, fodder, fuelwood, and diverse economic activities demand land and forest use. Therefore, an integrated approach may be needed for building strategies upon traditional knowledge, which may facilitate local participation and ensure sustainability.

Indigenous knowledge and management systems of fallows and vegetation regeneration are not yet very well understood. I would like to outline some suggestions for further research. For instance, first, one can observe that, when planting, Tsimane' combine *caij*, manioc and plantains, a process which has to do with shade management, structure, and the composition of plants. In fallows, the growth of vegetation resembles the growth of vegetation in primary forest. Cultivation results in patches of forest that grow at different altitudes. The mechanisms involved are local knowledge associated with a variety of crops locally adapted, dynamics of local vegetation, climate changes and soil distribution. The configuration of plots must be managed to maximize the effectiveness of the system. Second, it would be interesting to discover why the Tsimane' carefully observe climate changes, time of day, and lunar cycles when preparing plots, harvesting, and planting. Third, it would be useful to understand the underlying reasons as to why the Tsimane' do not go to the forest or to their plots after a woman gives birth; why they avoid sexual relations before planting; and why they are concerned about the odor of the individual, which is seen as causing danger and damage to hunting and crops. These all are definitely involved with management but less understood. To ensure long-term use of swidden areas and to have optimum swidden fallow cycles, the Tsimane' have to strictly observe this cultural domain in addition to the technique of management for maintaining productivity and conservation of the forest ecosystem.

The aspect of biological conservation is important but this may be useless if human needs are not satisfied and cultural diversity is overlooked. Participation of local peoples is important for sustaining resources and cultural diversity. These must be taken into account when promoting grassroots development in the communities and conservation in the park. The use of plants and land for fallow contribute to biological diversity, but it is also necessary to promote conservation on the basis of their existing beliefs about spirits and ancestors committed to conserving the forest.

The Tsimane' have developed a sustainable system of agriculture that works in the Amazonian area. They should be encouraged and enabled to continue without interference. In addition, their system provides important lessons for others in the following areas: how to integrate cycles of plant maturation and tree growth with cycles of fallow plot rotation in order to promote sustainable diversity and regeneration of forest in the Amazon regions; how to respect nature and the environment; and the importance of integrating agricultural systems into holistic sociocultural systems that are consistent with, and respectful of, human dignity and human rights.

APPENDIX A

SCIENTIFIC AND LOCAL PLANT NAMES FROM ASUNTA FALLOWS

Code	Tsimane' name	Source	Family	Genera /Species	Identifier
148	´Co´cop	**	Flac.	Casearia	
479	´Cu´cush	*			
480	´Cu´cush cayaya	*			
160	Achi' achi'	*	Leg. Pap.	Machaerium sp.	
1	Afare'	**	Sapot.	Pouteria reticulata (Engler) Eyma	R. S.
481	Ajfare'		Flac.	Casearia aff. gossypiosperma Briquet	R. de M.
155	Ajmo	**	Mor.	Pourouma minor Benoist	
161	Apaijniqui				
162	Arara'	**	Urt.	Urera laciniata (Goudot) Wedd.	R. de M.
163	Arara' Japa'ya	*			
164	Arara' M	*			
165	Arara' Ococoty				
544	Arosh				
64	Ashaba'	**	Mor.	Poulsenia armata (Miq.) Standley	
97	Ashaba'		Mor.	Poulsenia armata (Miq.) Standley	
521	Ashamba' son		Mor.	Sorocea sp.	
531	Ashashaj	**			
99	Ava ava' D	**	Flac.		
100	Ava ava' M	*	Flac.	Prokia crucis L.	
166	Ava avas avamo				
547	Avaj				
528	Bajna'	**			
2	Bañe' D	**	Gram.	Lasiacis divaricata (L) A. S. Hitchc.	
167	Bañe' M	*			
168	Basho'	***			
169	Batas				
3	Batas-son	*	Monim.	Siparuna	
170	Bätiñ				
72	Bejqui'	*	Leg. Pap.	Hymenaea courbaril L.	
171	Bese'	*	Mor.	Trophis sp.	
535	Binca'	**			
172	Birina'	*			
109	Birina'	**	Flac.	Casearia	
173	Biruruc	**			
447	Bitire'	*	Palm.	Attalea phalerata	M. M.
174	Bitiru		Annon.	Guatteria sp.	
175	Boboch	*			
176	Bojbori'		Palm.		
177	Bojno'ta	**	Elaeoc.	Muntingia calabura L.	R. de M.
138	Bonam'	*	Myrt.	Calyptranthes	
178	Boradyes	*			
505	Boreyety		Arac.	Monstera sp.	
67	Boshosho	**	Phytol.	Phytolacca bogotensis HBK.	
180	Bu'a	*	Zingib.	Costos sp.	
181	Bu'a o'toto'	**	Zingib.	Dimerocostus argenteus (R. & P.) Maas	R. de M.
182	Bucuj	**	Mor.	Indet.	
183	Bui'si'	***	Leg. Mimos.	Indet.	
524	Bui'si		Leg.	Indet.	

179	Buredyes	*			
184	Buru' buru'	*			
185	Cabij	*	Urt.	Phenax angustifolius (Kunth.) Wedd.	R. de M.
186	Cabiñ	*	Euph.	Acalypha sp.	
532	Ca'ij	**			
135	Ca'ij ca'ij	**	Conv.	Ipomaea	
136	Caijcani'	*	Smilac.	Smilax sp.	
187	Cajchicheru		Arac.	Philodendron sp.	
188	Cajchiri				
73	Cajnason	**	Flac.	Lunania parviflora Spruce ex Benth.	
189	Cajñere'	**	Bomb.	Ochroma pyramidale (Cav. ex Lam.) Urban	R. de M.
190	Cajpa '		Leg. Pap.	Erythrina sp.	
191	Cajtafa'	*	Palm.	Geonoma deversa (Pointeau) Kunth	M. M.
68	Cam	**	Myrist.	Virola sp.	
489	Caqui				
509	Cari cari		Palm.	Desmoncus polyacanthos Martius	M. M.
192	Catasare'				
193	Cavaquis	**	Combret.	Buchenavia sp.	
194	Cava'vas		Leg. Pap.	Desmodium sp.	
195	Cayaya'	**			
513	Chadye' chadye'		Borag.	Cordia sp.	
127	Chafuj	**	Myrist.	Virola sp.	
518	Chi papaj		Comp.	Mikania sp.	
5	Chichi'	*	Apocyn.	Allamanda cathartica L.	
83	Chij	**	Polygon.	Triplaris americana L.	
197	Chijchij				
200	Chip	*	Sterc.	Byttneria pescapraeifolia Britton	R. de M.
201	Chip		Malv.	Sida rhombifolia L.	R. de M.
199	Chip		Malv.	Sida setosa Mart. ex Colla	R. de M.
202	Chira'				
203	Chircatidye	*			
542	Chirimoya	***			
500	Chirimoya del monte		Annon.	Indet.	
371	Chito'	**	Leg. Pap.	Tephrosia vogelii J. D.	R. de M.
366	Chito' chito'	*	Leg. Pap.	Indet.	
494	Chochore'	*	Leg. Mimos.	Inga cf. capitata Desv.	R. S.
142	Chomindyedyes	**	Monim.	Mollinedia beckii Peixoto	
206	Chorecho'		Laur.	Indet.	
207	Chorecho' son		Laur.	Ocotea sp.	
208	Chosho' chosho'	**	Sapind.	Indet.	
502	Choshoty	*	Asclep.	Indet.	
204	Cho'vejve D	**	Mus.	Heliconia episcopalis Vell.	R. de M.
205	Cho'vejve M	*	Mus.	Heliconia sp.	R. de M.
84	Chuchujbui'	**	Cuc.	Gurania sp.	
495	Chuchun		Rub.	Posoqueria sp.	
209	Chu'chus	**			
95	Chuchuty	**	Asclep.		
380	Chuyety	*	Mor.	Pourouma sp.	
212	Cocharadyes (Uti')	*			
213	Cocharadyes (Puñi')	*			
214	Cochoro	*			

215	Cocomaj				
216	Cocope'	*	Palm.	Bactris major Jacq.	M. M.
217	Cocope' jajruj				
6	Cocos	**	Solan.	Solanum sp.	
219	Coi'dyes (con olor)				
218	Coi'dyes (sin olor)	*			
540	Cojcoj				
60	Cojma	**	Leg. Pap.		
7	Cojno'no	**	Leg. Mimos.	Inga	
234	Co'mori	*	Apocyn.	Prestonia robusta Rusby	R. de M.
541	Conei	***			
98	Conojoto'	**	Euph.	Hura crepitans L.	
220	Copo'tare	**	Elaeoc.	Sloanea fragans Rusby	R. de M.
110	Co'rivo	*	Zingib.	Renealmia sp.	
120	Coro'be'	*	Solan.	Solanum sp.	
10	Coroi'coroi D	**	Melast.	Miconia sp.	
221	Coroi'coroi M	*	Melast.	Miconia nervosa (Smith) Triana	M. M.
222	Coropan	*			
223	Coropan	*	Leg. Pap.	Indet.	
551	Cos	*			
211	Co'shi'	**	Leg. Caes.	Schizolobium sp.	
150	Coti'	**	Myrt.	Psidium guajava L.	
8	Cotison	**	Combret.	Terminalia	
224	Cotyijcotyij				
225	Coyoj (many)	**			
226	Coyoj coyoj	**			
229	Cucuñ	*			
230	Cucuñ	**	Acanth.	Sanchezia sp.	
231	Cujchuru'	*		Indet.	
232	Cujchuru'		Combret.	Combretum fruticosum (Loel f.) Stuntz	R. de M.
233	Cujtyuji'		Leg. Mimos.	Indet.	
74	Cüna'	*	Leg. Mimos.	Inga sp.	
227	Cu'na' D	**	Leg. Mimos.	Inga cerstediana Benth. ex Seeman	R. S.
228	Cu'na' M				
235	Cuñi	**	Diosc.	Dioscorea sp.	
9	Cunuro	*	Euph.	Hyeronima alchorneoides Fr. Alem.	
331	Cushrurus	*			
332	Cushrurus	*			
236	Cusitoñ	**			
237	Cutitu'	*	Sterc.	Byttneria sp.	
549	Dabaj				
243	Dabajdabaj	**	Meliac.	Trichilia rubra C. DC.	R. S.
239	Do'ñe	*	Maranth.	Ischnosiphon sp.	
240	Do'ñej do'ñej	*	Meliac.	Cedrela sp.	
241	Do'ñej do'ñej	*			
504	Doradyes (many)		Theopr.	Clavija lancifolia Desv. S. L.	R. de M.
242	Dororo'				
238	Doshiri	*	Verb.	Lippia sp.	
11	Doto	**	Ulm.	Trema integerrima (Beurl.) Standley	
506	Dujradyes		Conv.	Ipomaea sp.	
75	Dujredyes coro'be'	*	Comm.	Dichorisandra sp.	
159	Dyijdyedyes	*	Guttif.	Calophyllum brasiliense Cambessedes	

76	Dyincava'	**	Cuc.	Fevillea sp.	
57	Dyivavaj	**	Burs.	Protium sp.	
245	Dyujdyuj	**	Laur.	Nectandra sp.	
246	Dyu'ñej	**	Maranth.	Calathea sp.	
247	Dyuñui'				
244	Dyu'rurus	**	Chrysob.	Licania sp.	
49	E' jaisi D		Leg. Caes.	Bauhinia	
149	E' jaisi M		Leg. Caes.	Bauhinia	
248	E'asi	*			
249	E'ejtsere'	*			
250	Emej emej	**	Theopr.	Clavija weberbaueri Mez.	R. S.
65	Emety tara' tara	*	Flac.	Hasseltia floribunda HBK.	
12	Ere' ere'	**	Ulm.	Celtis iguanaea (Jacq.) Sarg.	
536	Erepaj	**			
251	Faj	**			
252	Faj faj	**	Burs.	Protium sp.	
499	Faj faj D		Elaeoc.	Sloanea sp.	
254	Fuj fuj	**	Bomb.	Ceiba sp.	
487	Fujfuna		Mor.	Ficus sp.	
253	Fu'u'	*	Pter.	Trichipteris procera (Willd.) Tryon = Cyathea procera	J. G.
257	Ibam'ta	*	Rut.	Galipea sp.	
157	Ibijqui	**	Guttif.	Rheedia gardneriana Pl. & Tr.	
56	Idyeñi		Passifl.	Passiflora triloba Ruiz & Pavon ex DC.	
258	I'fo'	*	Bix.	Bixa urucurana Willd.	R. de M.
63	Ijsi'ta	**	Mor.	Pseudolmedia cf. laevis (Ruiz & Pavon) J. F. Macbride	
259	Ijsi'ta	*			
260	Ijtapa'shi	*			
255	I'ñishu	*	Leg. Mimos.	Inga sp.	
256	I'seji'		Leg.	Indet.	
121	Itison	*	Simar.	Picramnia latifolia Tul.	
13	Itsi	**	Simar.	Picramnia sellowii Planch.	
261	Itsison	*	Leg. Pap.	Indet.	
131	Ivaj ivaj	*	Pip.	Piper pelatum L.	
59	Iviñu'	**	Comm.	Dichorisandra sp.	
262	Iyason	**	Ros.	Prunus sp.	
263	Iyo'po-son	*	Leg. Mimos.	Pithecellobium latifolium (L.) Benth.	R. de M.
264	Jadyedye	*			
265	Jajru'	*	Palm.		
266	Japa'ya D	**			
77	Japa'ya M	*	Euph.		
145	Jayedyedyes	*	Sabiac.	Meliosma	
103	Jere'dyis D	**	Leg. Mimos.	Inga sp.	
102	Jere'dyis M	*	Leg. Mimos.	Inga sp.	
267	Jerejres D	**			
15	Jichi	**	Polygon.	Triplaris poeppigiana Wedd.	
101	Jifis Jifis	*	Monim.	Mollinedia beckii Peixoto	
269	Jiji'				
16	Jiji'son	*	Sapot.	Pouteria	
270	Jishojshos	*	Leg. Mimos.	Indet.	
14	Jivin D	**	Cyp.	(esteril)	
268	Jivin M	*			

17	Joro'co	**	Passifl.	Passiflora cossinea Aubl.	
271	Joroson	*	Meliac.	Guarea cf. guidonia (L.) Sleumer	R. de M.
71	Joyo'		Sterc.	Sterculia	
61	Joyo' D		Leg. Pap.		
62	Joyo' I	*	Leg. Pap.	Ormosia	
273	Jucus	*			
512	Judyeyety			Indet.	
492	Juto juto		Comp.	Kaunia sp.	
537	Limonara	**			
276	Majpiva	*	Nyct.	Neea cf. spruceana Heirmel.	R. de M.
277	Mana'i	**	Palm.	Attallea phalerata	M. M.
533	Manca	**			
275	Ma'ñere'	*	Palm.	Euterpe precatoria Mart.	
274	Mapuri				
529	Maraca	**			
111	Mara'jitity	**	Leg. Mimos.	Inga sp.	
151	Mase'	*	Mor.	Pourouma sp.	
525	Merique	**			
278	Misan	*			
279	Mito	**	Rub.	Indet.	
510	Mitoj mitoj		Polygon.	Coccoloba sp.	
280	Mo'cam				
122	Moco'	**	Anac.	Spondias mobin L.	
284	Mojmoty	**	Leg.	Indet.	
285	Moño' moño'	**	Aral.	Dendropanax arboreus (L.) Decne & Plancher	R. de M.
484	Mono' mono' M	*	Rub.	Palicourea sp.	
281	Morifi	*	Comm.	Dichorisandra sp.	
19	Movai'	**	Mor.	Pourouma cecropiifolia Mart.	
78	Mu'	**	Til.	Heliocarpus americanus L.	
282	Mujmoñe	**			
18	Mujpe'	**	Mor.	Ficus sp.	
283	Mujpere'	**	Euph.	Sapium sp.	
286	Muru' muru'	*	Rub.	Indet.	
287	Muru' muru' D	*			
288	Muru' muru' D				
289	Murujrudyety	*			
290	Murujyadyety	*	Pter.	Lomariopsis jupusensis (Mart.) J. Sm.	J. G.
291	Mushisha				
20	Mu'suruj	**	Mor.	Claricia cf. biflora Ruiz & Pabon	
292	Muvaru		Euph.	Tetrochidium rubrivenium Poeppig	R. S.
79	Na' i	**	Aral.	Didymopanax sp.	
294	Naba'ba'				
125	Na'fa'	**	Burs.	Tetragastris altissima (Aublet) Swart	
516	Namai'		Arac.	Anthurium oxycarpum Poeppig	R. de M.
139	Na'me	**	Leg. Mimos.	Inga sp.	
293	Na'me	*			
295	Natchaisi	*			
514	Nej jebei		Solan.	Cuatresia aff. forsteriana A. Huns.	R. de M.
93	Ñej ñej	*	Annon.		
119	Ño' foi D	*	Laur.		
112	Ño' foi M	*	Annon.		

113	Novei'	**	Ulm.	Celtis schippii Standl.	
80	Ñu'bubu'	*	Sapind.	Paullinia cf. alta (Ruiz & Pavon) Don	
493	Nunej nunej		Meliac.	Trichilia rubra C. DC.	R. S.
296	Oba'		Bomb.	Ceiba sp.	
297	Ococoty D	**			
298	Ococoty M	*			
299	Ocoya	*	Bomb.	Pachira sp.	
436	Oijnis	*	Melast.	Aciotis sp.	
301	Ojdo	**	Palm.		M. M.
45	Ojme'ro	**	Sapind.	Paullinia sp.	
302	Omin'dye'		Mor.	Indet.	
86	Ono' ono'	**	Urt.	Urera cf. caracasana (Jacq.) Griseb.	
303	Ono' ono'				
87	Onomaj	*	Passifl.	Passiflora sp.	
51	O'ojvi	**	Comp.	Vernonia sp.	
304	Opaj Opaj	*	Mus.	Heliconia sp.	
305	Opoj Opoj u Opospere	*			
522	Opospere'		Mus.	Heliconia sp.	
144	Ororona'	**	Caric.	Jacaratia cf. digitata (Poepp & Endl.) Solms	
306	Orota' orota'	*			
511	Oteti	*	Orch.	Indet.	
44	Oveto'	**	Rub.	Uncaria guianensis (Aublet) Gmelin	
307	Oveto'	*			
530	O'yi	**			
439	Oyoj oyoj	*	Sapind.	Urvillea sp.	
21	Pacaya	**	Leg. Mimos.	Inga sp.	
309	Pan'dyej pan'dyej	*	Apocyn.	Prestonia sp.	
310	Pan'dyej pan'dyej	*			
311	Pa'ñej (Tyi)	*	Rub.	Genipa americana L.	R. de M.
312	Patsi're	**	Leg. Pap.	Desmodium adscendens (Sw.) DC.	R. de M.
308	Pa'tyi'pa'tyi'	*	Leg. Caes.	Senna pendula (Willd.) I & B. var. praeandina Irwin & Barneby	R. de M.
313	Paya	**			
527	Pe're	**			
314	Pimi (ij'si'ta)	*	Mor.	Pseudolmedia laevis (R. & P.) Macbr.	R. de M.
315	Pinana'	*	Euph.	Croton sp.	
316	Pipim D	**	Maranth.	Calathea sp.	
519	Pipim M		Maranth.	Ischnosiphon sp.	
118	Pise're	*	Annon.		
22	Pishi pishi	*	Melast.	Mouriri myrtilloides (Sw.) Poiret	
317	Pishi'shi'	*			
534	Pofi	**			
318	Pofipururus	*	Caric.	Carica sf. microcarpa Jacq.	R. de M.
485	Pofipurus (jainas)		Begon.	Begonia sp.	
114	Pomo (ij'si'ta)	**	Mor.	Pseudolmedia macrophylla Trecul.	
319	Popots				
321	Pucraras	**			
320	Pucraraty	*			
23	Pucucus D	*	Myrist.	Iryanthera juruensis Warb.	
25	Pucucus M		Myrt.		
152	Pucuj	**	Lecyth.	Schweilera sp.	

322	Pucuj				
140	Pujpurum'sha	*	Rub.	Coccocypselum lanceolatum (Ruiz & Pavon) Pers.	
368	Puñipo		Guttif.	Symphonia globulifera L. ?	R. de M.
323	Punujyadyes	*	Hippocr.	Indet.	
24	Pupuc M	**	Euph.	Alchornea sp.	
501	Quetetse		Haemod.	Xiphidium caeruleum Aublet	R. S.
325	Quetyejfe'	*	Dillen.	Doliocarpus dentatus (Aubl.) Standl.	R. de M.
324	Quetye'tye	**			
326	Quijtsi		Euph.	Phyllantus acuminatus Vahl.	R. de M.
327	Quiñu'	*	Diosc.	Dioscorea sp.	
329	Quipi'mita	*	Leg. Mimos.	Indet.	
333	Ro'bodye'	*	Bromel.	Guzmania sp.	
482	Ro'bodye (Joris)	*	Orch.	Vanilla sp.	
334	Ro'bodye'	*			
126	Robo'robo'	**	Comp.	Mikania	
335	Rojdyety		Erythy.	Erythroxylum sp.	
81	Rojroj	**	Viol.	Leonia racemosa C. Martius	
336	Royeyes	**	Mor.		
337	San'	**	Asclep.	Indet.	
338	Sejsame		Leg. Caes.	Senna cf. alata (L.) Roxb.	R. de M.
134	Sequej	**	Annon.		
339	Shaba D	**			
28	Shaba' M	*	Chrysob.	Hirtella bullata Betham	R. S.
104	Shaba' shaba'	**	Selag.	Selaginella anceps (C. Presl) C.Presl	
105	Shaba' shaba'	*	Pter.	Diplazium	
106	Shaba' shaba'	*	Pter.	Thelypteris	
342	Shaba' shaba'	*	Dryopt.	Polybotrya caudata Kunze (JG)	
343	Shaba' shaba'	*			
29	Shabaji'	**	Caprif.		
340	Shaba'jitity	*	Lythr.	Lafoensia sp.	
341	Shabasha	*			
32	Shacaj shaca	**	Guttif.	Marila	
33	Shacsis	**	Dillen.	Tetracera parviflora (Rusby) Sleumer	
196	Shacsis		Rub.	Indet.	
48	Shai'dye Shai'dye	*	Sapind.	Alphyllus sp.	
31	Shai'dye Shoi'dye	**	Rut.	Ticorea tubiflora (A.C. Smith) Gereau	
345	Shaj	**	Leg. Pap.	Erythrina sp.	
346	Shajquiba'		Mor.	Batocarpus sp.	
347	Shajrashan				
30	Shajru'bi	**	Leg. Pap.		
496	Shanajna		Leg. Mimos.	Inga cf.nobilis Willd	R. S.
545	Shandia				
348	Shanimo	*			
349	Shanoma'				
350	Shara'	**			
351	Shashac				
352	Shashity				
483	Shashuch M	*	Hippocr.	Indet.	
82	Shaya'cas D	**	Annon.		
92	Shaya'cas M	*	Annon.		
344	Shayimo'	*	Viol.	Rinorea cf. viridifolia Rusby	R. de M.
353	Shejdyes	*			

354	Shejsherena	*	Elaeoc.	Sloanea sp.	
355	Shepi'	*	Ulm.	Ampelocera sp.	
107	Shevijriqui'	*	Sapind.	Sapindus saponaria L.	
356	Shevin				
66	Sheya	**	Comp.	Erechtites hieracifolia (L.) Raf.	
357	Sheye' sheye'				
34	Sheyejye' D	**	Meliac.	Guarea kunthiana Adr. Jussieu.	
358	Sheyejye' M	*	Meliac.	Guarea sp.	
35	Shi' shi'	**	Rub.	Psychotria sp.	
360	Shibo'	**	Palm.	Astrocaryum murumuru c. Martius	M. M.
359	Shi'ety				
132	Shiquity	**	Leg. Pap.		
362	Shiriva'	*	Myrt.	Calyptranthes sp.	
363	Shishi	*	Solan.	Capsicum sp.	
115	Shishi'butu	*	Rub.	Alibertia pilosa Krause	
364	Shi'si'	*			
365	Shitri	*	Leg. Pap.	Indigofera suffruticosa Mill.	R. de M.
367	Shivajtuqui				
36	Shiveñi	**	Vit.	Cissus sicyoides L.	
546	Shobo				
128	Shoijno	**	Euph.		
369	Shojboboty	*	Pip.	Peperomia rotundifolia (L.) H. B. K.	R. de M.
523	Shomboboty D		Pip.	Peperomia sp.	
370	Shono	*			
69	Shoñoj	**	Anac.	Tapirira guianensis Aublet	
515	Shoshoboy		Cuc.	Indet.	
372	Shoshoch	*	Apocyn.	Allamanda cathartica L.	R. de M.
141	Shu' juju'	*	Rub.		
374	Shucujshañ				
375	Shudyaty	*			
376	Shufada				
497	Shujdyushan	*	Spind.	Matayba sp.	
498	Shujdyushan	*	Bign.	Indet.	
378	Shuru' Abujre	**			
377	Shuru'	*	Gram.	Gynerium sagittatum (Aubl.) Beauv.	R. de M.
94	Shuru' shuru'	**	Rub.	Ixora peruviana (spruce ex Schum.) Standley	S. B.
379	Shushoy	**			
373	Shu'vuvus	**		Indet.	
381	Shuyuj shuyuj	*			
137	Shuyuva	*	Euph.	Acalypha benensis Britton	
382	Sijmimi	**			
85	Sijmuri	*	Apocyn.	Himatanthus sucuuba (Spruce) Woodson	
27	Sijpecheche	*	Annon.		
383	Sijta (sujta)		Comp.	Tessaria Integrifolia R. & P.	R. de M.
37	Sima'	**	Mor.	Ficus	
384	Simurin	**			
385	Siñuj	**	Maranth.	Monotogma sp.	
386	Sipi sipi	*			
491	Siribay		Myrt.	Marliera sp.	
388	Sisi'	*	Apocyn.	Prestonia sp.	
389	Sivii'		Salic.	Salix humboldtiana Willd.	R. de M.

70	Siyamo	*	Meliac.	Cedrela	
390	Sojsoty	*	Ulm.	Ampelocera edentula Kuhlm. (RS)	R. S.
400	Soro'	**	Mor.	Cecropia sciadophylla Martius	R. de M.
38	So'rocaj	*	Sapot.	Pouteria cf. torta (Mart.) Radlk.	
387	Su'rij	*	Maranth.	Monotogma cf. laxun (P. & E.) K. Schum.	R. de M.
116	Susuty	**	Ulm.	Ampelocera edentula Kulhm.	R. S.
391	Suyuj	*			
394	Ta'	**			
392	Ta'	*			
538	Ta' (chili)	***			
393	Ta'I	*	Gnet.	Gnetum sp.	
395	Ta'babas	*			
397	Tamij tamij	*			
398	Tamtac (ibam'ta)	***	Rut.	Pilocarpus sp.	
39	Tapi	*	Cyclanth.	Thoracocarpus sf. bissectus (Vell.) Harling	
543	Tara'				
143	Tara' tara'	**	Mor.	Clarisia	
399	Tatetsjos (tijtesos)	**	Euph.	Mabea cf. anadena Pax & Hoffm.	R. de M.
396	Tavo' tavo'	*	Flac.	Casearia sylvestris Sw.	R. S.
486	Tchijtyi tchijtyi	*	Menisp.	Curarea toxicofera (Wedd.) B. & K.	R. de M.
401	Tijchi'	*			
402	Tin'dye tin'dye	*	Menisp.	Abuta sp.	
403	Tinye (Tyej)	**	Mor.	Cecropia sp.	
404	Tiribu'	*	Hippocr.	Salacia sp.	
40	Tiribu' D	*	Hippocr.	Salacia sp.	
405	Tiribu' M		Hippocr.	Salacia sp.	
50	Tiribu' M	**	Hippocr.	Salacia sp.	
123	Titij	**	Mor.	Ficus cf. insipida Willd.	
422	Tojyo'	*			
503	Ton'				
407	Totoij				
43	Totop	*	Passifl.	Passiflora sp.	
406	Toto'ra				
424	Totora	*	Arac.	Anthurium clavigerum P. % E.	R. de M.
408	Tsajfa'fa	**	Laur.	Ocotea aff. longifolia H. B. K.	R. de M.
409	Tsajfa'fa	*	Laur.	Indet.	
410	Tsanaj	**	Mor.	Cecropia sp.	
411	Tsaruj tsaruj	*	Myrt.	Marliera sp.	
41	Tserac tserac	**	Myrt.	Calyptranthes aff. speciosa Sagot	
412	Tsijtyi' tsijtyi'	*			
133	Tsi'mac D	**	Solan.	Solanum albidum Dunal	
413	Tsiñi' tsiñi'	**			
414	Tsiñi' tsiñi' D	*	Bign.	Macfadyena uncata (Andr.) Sprague & Sandow.	R.S.
415	Tsiñi' tsiñi' M	*	Elaeoc.	Sloanea sp.	
130	Tsocon'	**	Guttif.	Rheedia cf. brasiliensis (Mart.) Planch. & Triana	
416	Tso'vety	*	Palm.		
417	Tso'vety				
96	Tsuni	**	Sterc.	Sterculia	
418	Tsuni				
520	Tsu'ri		Maranth.	Calathea sp.	
419	Tu'u	*			

420	Tu’u	*			
507	Tubuij		Rhamn.	Gouania adenophora Pilger	R. de M.
42	Tubuij	**	Rhamn.	Gouania sp.	
421	Tuichi	*	Annon.	Xylopia sp.	
272	Tunenes	*			
423	Tuperoj	*			
425	Tutyi'		Annon.	Xylopia aff. ochrantha Mart.	
426	Tyej	**			
427	Tyejson	***	Mor.	Pourouma sp.	
428	Tyi	*			
361	Tyicdye tyicdye	***	Euph.	Margaritaria nobilis L.	
198	Tyi'mujmure'	**			
26	Tyi'mus		Campan.	Centropogon cornutus (L.) Druce	
330	Tyururu'	**	Mor.	Cecropia sp.	
210	Tyutyu'ra	*	Palm.	Mauritia flexousa L. f.	M. M.
434	Uchi' uchi'	*			
435	Udult	*			
429	U'fa'	**			
300	Undye	*	Arac.	Anthurium sp.	
437	Upaj Upaj	*			
46	U'puyu'	**	Pip.	Piper glabratum Kunth	
430	U'puyu' (boshosho)	*			
432	U'puyu' D	*	Pip.	Piper obliquum Ruiz & Pavon	R. de M.
433	U'puyu' I	*	Pip.	Piper sp.	
431	U'puyu' M	*	Pip.	Piper sp.	
438	Uru' uru'		Arac.	Philodendron sp.	
47	Uti'	**	Bign.	Jacaranda copaia (Aubl.) D. Don	
440	Vada'ca	*	Passifl.	Passiflora sp.	
526	Vaij	**			
517	Vaijsi vaijsi		Sapind.	Cardiospermum grandiflorum Sw.	
508	Vaisi vaisi		Sapind.	Serjania sp.	
444	Vai'si'ma	*	Chrysob.	Hirtella aff. racemosa Lam.	R. de M.
153	Vajbason	*	Flac.		
441	Vapi	**	Meliac.	Guarea sp.	
442	Vara vara'	*	Chrysob.	Hirtella sp.	
52	Vara'i vara'i	*	Monim.	Siparuna decipiens (Tul.) A. DC.	
548	Varusa				
89	Vashi'	**	Sapind.	Serjania sp.	
90	Väväij	**	Mor.	Clarisia	
443	Väväjtis		Leg. Caes.	Bauhinia sp.	
490	Vavajtis		Leg. Pap.	Machaerium sp.	
445	Vayori		Hernand.	Sparattanthelium Glabrum Rusby	R. S. & R. de M.
53	Vayuna'	**	Rut.	Zanthoxylum sp.	
146	Vayuna'		Meliac.	Cedrela	
446	Vejchuj	***			
117	Ve'pi'			Indet.	
54	Ve'pi'	**	Meliac.	Cedrela	
55	Vetere	**	Leg. Mimos.	Acacia	
156	Vetere	*	Annon.		
448	Veya	*	Annon.	Duguetia spixiana Mart.	R. de M.
451	Vicoi'		Borag.	Cordia sp.	

452	Vijri	**	Palm.		
453	Vijyo	**			
158	Vim'ta'		Mor.	Ficus	
454	Vinaj	**	Myrsin.	Stylogyne cauliflora (Mart.& Miq.) Mez	R. de M.
328	Vinanac		Passifl.	Passiflora vespertilio L.	R. de M.
154	Vinsi vinsi		Sapind.	Cardiospermum grandiflorum Sw.	
539	Viroj	***			
88	Virui'	**	Leg. Mimos.	Inga sp.	
456	Visaru'				
457	Vishi	*			
458	Vishi' vishi'		Nyct.	Neea cf. spruceana Heirmel	R. de M.
459	Vishi'ri	**	Leg. Mimos.	Inga marginata Willd.	R. S.
468	Vishishi				
460	Vi'si		Burs.	Protium aracouchini (Aublet) Marchand	R. de M.
449	Vi'sison	*	Burs.	Protium aracouchini (Aublet) Marchand	R. de M.
450	Vi'sison				
455	Visu' visu'	*			
461	Vo'codyes	*	Euph.	Jathropha curcas L.	R. de M.
462	Vojro		Palm.		
463	Vojshina	*	Bomb.	Chorisia sp.	
464	Vojshina				
467	Vorayety		Arac.	Philodendron sp.	
465	Vosho'vosho'		Gesn.	Drymonia semicordata (Poepp.) Wiehl.	R. de M.
466	Voyej voyej	*	Comp.	Vernonia megaphylla (Hieron.) H. Robins.	R. de M.
4	Vujvu'ri	**	Laur.		
470	Yäcãñi				
471	Yadada'	*	Sapind.	Allophylus cf. punctatus (Poepp. & Endl.) Radlk.	R. de M.
472	Yäjdyädya		Guttif.	Calophyllum sf. longiphyllum Willd.	R. de M.
474	Yaraj Yaraj		Palm.		
473	Yati	*			
469	Ya'tyi'	**			
129	Yäyän	**	Rub.	Hamelia patens Jacq.	
488	Yayan D		Rub.	Palicourea sp.	
147	Ye'res		Leg. Mimos.		
58	Yic	*	?		
91	Yovishi	*	Solan.	Capsicum coccineum (Rusby) A. Hunz.	
475	Yububu'		Sapind.	Serjania sp.	
476	Yujyo		Pter.	Alsophila cuspidata (Kunze) Tryon	J. G.
477	Yujyuj				
124	Yutij	**	Rub.	Randia sp.	
478	Yuyujna	*			
108	Yuyujna	**	Borag.	Cordia nodosa Lamarck	

♦ (R. S.) Renate Seidel, (S. B.) Stephan Beck, (J. G.) Jasivia Gonzales, (M. M.) Monica Moraes, (R. M.) Rossy de Michel
I= Itsunquis (small)
M=Miquis (medium)
D=Darjsi (large)
* Data completed by informants
** Data from transects
*** Data from interviews

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