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Corn/cattle/care| Farm tree and agroforestry practices in Saraguro, Ecuador

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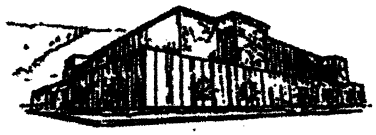

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CORN / CATTLE / CARE:

FARM TREE AND AGROFORESTRY PRACTICES IN SARAGURO, ECUADOR

By

Mark Richard Olson

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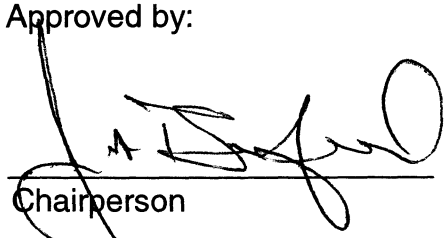

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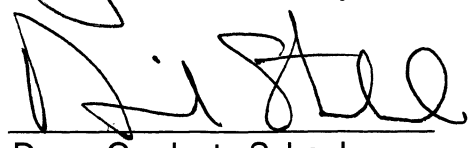

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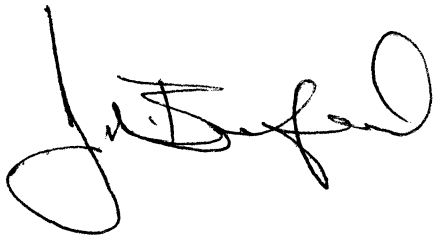

Rural households in the tropics plant trees for a number of reasons. Tree planting is often a response to declining forest resources, to meet demands of new markets, to increase agricultural productivity, or to reduce risk in food cycles and to secure land tenure rights. Household tree-use is divided into productive and protective uses. Productive uses include food, firewood, construction material, medicine, and fodder. Protective uses are windbreaks, nitrogen fixing, shade, and soil conservation. Faced with the complexity of household tree use, many past tree-based development programs have been unsuccessful. Research centering on livelihood strategies has proved to be helpful in understanding how and why households use trees.

In Saraguro, Ecuador, household tree use has gone through many changes since the 1940's. The land in the basin is owned almost exclusively by individual indigenous households. Because of large scale conversion of forests to pasture, Saraguros have increased tree planting on their farms. This study seeks to understand the types and distribution of agroforestry systems and to uncover any patterns of tree use across households.

A complex set of factors contributing to a household's livelihood strategy were found to influence household tree use. Present day tree use was found to be influenced by a number of historical events. The completion of the Pan American Highway through Saraguro led to large scale deforestation through conversion of forests to pasture for commercial cattle production. Thirteen years of reforestation efforts by CARE changed species composition and patterns. Tree use at the household level was also found to be influenced by quality of land, security and self-sufficiency in terms of food, firewood, and construction material, and household decisions regarding engagement in the market economy. All of these factors were found to influence tree use on the household level, but because of the dynamic nature of these interacting factors, generalizations on tree use across households were very difficult to make.

This study illustrates the value of the livelihood strategy approach for understanding tree use at the household level. It offers a set of factors that can be used in future studies to understand household tree use.

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I Introduction

This study is the result of two and a half years living in the southern highlands of Ecuador as a Peace Corps volunteer. As a volunteer, I was assigned to the multi-ethnic community of Saraguro. The term Saraguro is a Quichua word meaning *land of corn* and is used to denote an indigenous group, a town, a Parish, and a Canton (county). Working mainly with the indigenous population on natural resource issues, I slowly came to understand aspects of the group's history and culture and how they relate to natural resource use. While living there, I became interested in understanding the factors that contributed to the present day tree-use practices and patterns I was seeing on the land. What ecological, historical, ecological, social, cultural, economic, and political factors have contributed to the present patterns and processes I observed on the land? How could I begin to unravel this complex mesh of factors and how could I apply those findings to issues in tree-based agroecosystem development?

This study builds on a long line of Andean scholarship going back to Carl Sauer and Carl Troll. Sauer sought to place cultures and the landscapes they helped to create in a temporal context and to understand the co-evolutionary process of landscape change (Sauer 1941). Social-ecological studies continue into the present in the works of Karl Zimmerer (1996, 1998) and Daniel Gade (1975, 1999) among others. These studies focus on the human – ecosystem interface and how it has been shaped by historical, social, economic, and political factors.

Cultural and political ecology have been particularly helpful in framing this study. Cultural ecology seeks to understand the role of culture in traditional land-use systems in the developing world and the impacts of outside influences (Keese 1998). Building on the foundational works of Steward (1955), and others (Bateson 1972; Belote 1984),

cultural ecology focuses on the adaptive strategies of local people and ecosystems in response to these changes. Political ecology builds upon these important works by integrating land-use practices and adaptive strategies into the larger political and economic systems. Political ecology as an approach to ecological and social interaction, emphasizes the need to consider the current patterns and practices of site specific locations within the larger context in which they operate – both over time and across space (Neumann 1992; Keese 1998; McCarthy 2002; Walker 2005). Neumann's (1992 p.87) definition of political ecology's approach is most useful to my study. He writes,

> Political ecology entails: (1) a focus on the land user and the social relations in which they are entwined; (2) tracing the linkages of these local relations to wider geographical and social settings; and (3) historical analysis to understand the contemporary situation.

As a Peace Corps volunteer not knowing where I was to live until a couple months into my training, I did not have the opportunity to thoroughly review the literature relevant to my research question before I began my study. All of the research was done *in situ* and is a combination of interviews, mapping, archival and historical research. Later in the process, I realized that my work resonated with the grounded theory approach in that it respects how patterns and themes develop from the collected data, not necessarily from hypothesis to be tested or derived from the literature or a preconceived theoretical construct. My study relies on past research in done in Saraguro by James and Linda Belote (1978; 1984), Dennis Ogburn (2001), and Ruthbeth Finerman and Ross Sackett (2003). James Belote's (1984) work on the adaptive strategies of the Saraguros between 1900 and 1984 is particularly useful for the present study.

The core of this study is based on 27-months of ethnographic research. The study has three main objectives:

- First, it seeks to understand, at the level of the household, the types and distribution of tree incorporating land-use systems in the Saraguro basin. This includes identifying the main tree / shrub species, their arrangement, their uses, the household characteristics on the farm the trees are found, and landowner rationale for having the specific systems and species.
- Next, the paper analyzes this data to uncover themes and patterns in how livelihood strategies influence farm tree and agroforestry practices on the household level.
- Lastly, it explores the role CARE played in affecting change in species composition and patterns in Saraguro as a result of 13 years of reforestation efforts.

The paper is divided into six sections: The first section reviews the relevant literature that will be employed in subsequent analysis. The second section covers the research methods used in the study. The third provides the context for the study; outlining the setting and history. The fourth section reports the findings, and the fifth discusses the meaning and importance of these findings. Lastly, I close the paper with some concluding thoughts and implications for future tree-based development programs.

II Literature review

Decades of research on rural socio-ecological systems suggest that households in the tropics plant trees for many different reasons (Arnold 1991; Laarman and Sedjo 1992; Arnold 1995). Tree uses generally are divided into productive and protective uses or functions (Nair 1989; Laarman and Sedjo 1992; Scherr 1995). Productive uses include: construction material and firewood, food, fodder, medicine, and dyes. Protective uses are: wind breaks, living fences, nitrogen fixing, fertilizer, moisture content retention, filtration, shade, and soil conservation. Trees therefore, contribute in multiple ways to a household's livelihood strategy. These uses can be understood on both the subsistence and commercial level. Most rural and peasant households participate to some degree in a market economy (Arnold 1991). Trees can contribute to a household's cash income through the selling of fruit, wood, firewood, or fodder. Farm trees then, play a role in meeting subsistence needs and generating income.

Increases in the number of trees households' plant are often associated with four factors (Arnold 1995; Scherr 1995):

- To maintain self-sufficiency of tree products due to decrease in off farm resources or loss of access rights.
- To meet growing demands as a result of population increase or new markets.
- To combat loss of productivity on agricultural or pasture land.
- To reduce risk in yearly production cycles or to secure land rights.

Within these broad incentives, there is considerable variability. When faced with one or all of these factors, household will increase tree planting only if other factors come into play. Whether a household chooses to increase tree stocks on their land also depends on agroecological zone, type of agricultural / livestock systems, market

options, size and quality of landholdings, and alternatives to tree products (Arnold 1995).

Faced with the complexities of increased household tree use, national and international reforestation efforts have tried a number of different approaches. In the 1970's and 1980's, development efforts promoted growing trees to combat perceived threats of deforestation, environmental degradation, and a decline in agricultural productivity (Arnold 1995). Many of these efforts focused on community forestry. These projects worked to establish plantations on community-owned land to increase tree densities and provide alternatives to cutting forests. These efforts largely failed for a number of reasons. First, the efforts came out of perceived global problems instead of the actual needs of the farmers (Laarman and Sedjo 1992; Arnold 1995). Second, many problems were encountered in doing forestry, based on a misunderstanding of what constitutes a community and its role in rural development and natural resource management (Laarman and Sedjo 1992; Agrawal and Gibson 1999). The idea that everyone in a community thinks and acts the same and that all have identical needs, influenced the thinking in community forestry early on. These efforts did not consider that communities are made up of various groups with differing interests and that benefits gained from trees are frequently dependant on social class, land security, gender, age, and power (Agrawal and Gibson 1999).

These errors gave way to a more narrow focus on households and farms (Arnold 1991; Laarman and Sedjo 1992). Early research in farm and social forestry overcame many of the problems inherent in community forestry, but still suffered from a one dimensional and static view of processes that are inherently dynamic and complex (Arnold 1995; Scherr 1995). Much of this work can be summed up by the "needs approach" that focused on scarcity and the role trees play in fulfilling a need (Eckholm

1975; FAO 1978; Lundgren 1982; Nair 1985). This approached suffered failures, because it did not take into account the complexity and dynamics of a household's decision to plant trees. First, a household's needs are not static but change over time (Arnold 1995). Second, it does not take into account alternatives to tree use and other household objectives (Arnold 1995). Subsequent research uncovered the weaknesses of such a view and more sophisticated frameworks have been proposed (Arnold 1995; Scherr 1995; Scoones 1999).

A. Livelihood Strategies

Work using an analytical framework centering on the concept of "livelihood strategies" has been useful. Livelihood strategies encompass everything a household does to meet basic needs, typically by maximizing security and minimizing risk (Holden et al. 1991). Warner (2000 p.9) defines "livelihood" as comprising:

> The capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

Assets can be understood as the various types of capital available to any household including natural, financial, social, and human. The more assets one has, the more options they have to change their livelihood strategies when faced with a change (Warner 2000). Access to and control over resources are of critical importance for a livelihood. This entails private landholdings, common property, or open access land. For households with a secure land base, key elements include the size and quality of landholdings, the agroecological zone the lands occupy, and the larger historical-social-economic context in which the landholdings operate. Access and control over land-based resources are not contested in Saraguro, because the indigenous population has had secure land tenure for almost three hundred years (Belote 1984).

Food security is a key aspect of a livelihood strategy. In this context livelihood strategies are concerned with crop/food security and stability over maximizing the production of a cash crop (Altieri 1995). In some situations, the small farmer will rely on trees (either trees on their land or trees from forest/community land) to supplement main subsistence crops, generate income, provide firewood, and provide other needs (Arnold 1991; Laarman and Sedjo 1992). In Saraguro, fruit trees are an important component of food security. Every household has at least a few fruit trees that they use for their subsistence. In Saraguro, trees also play an important role in firewood and construction material security and self-sufficiency.

Off-farm employment and market engagement can also be a part of a household's livelihood strategies. Components affecting market engagement can be access to markets, normal market fluctuations and cycles, and periodic stresses or shocks from economic factors such as market collapse or ecological processes like fire, long term drought, or landslides. In Saraguro, tree use is to a large extent determined by a household's market engagement strategy, especially on-farm commercial production.

A detailed analysis of livelihood strategies must be able to incorporate influences from multiple scales. It is not just the landholdings and local context which influence household livelihood strategies but also multiple factors from the regional, national, and international levels. State policy and programs can influence livelihood strategies in a number of ways through subsidies, infrastructure, land reform, extension programs, and trade policies.

International organizations in the form of NGO's (Non-Governmental Organizations) are playing an increasing role in a household's livelihood strategies (Meyer 1993; Keese 1998; Wunder 2000). They are also becoming an important area of study because of the impacts they exert on the local level. An analysis of

organizations is concerned with how they transfer resources and ideas to rural areas in the developing world and how local actors respond (Keese 1998). Much has been written on the NGO discourse and how the problems they identify and the crises they create are contested (Zerner 1996; Bassett and Zueli 2000; Leach and Fairhead 2000). But less has been written about how NGO's adapt and change as a result of their encounters within local settings and with local actors. The international NGO CARE worked for 13 years in Saraguro in reforestation programs. The main impacts of CARE's work have been the introduction of a number of exotic species (including eucalyptus, pine, aliso, acacia, apple, peach, and plum) and the transfer of their technical knowledge in regards to tree growing and care. CARE's work in Saraguro has had a number of positive and negative effects which will be explored in-depth in the findings section.

In this framework, farm tree and agroforestry strategies are to a large extent, determined by a household's overall livelihood strategy and entire resource base (Rocheleau 1987). This paper contends that to understand a household's decision-making process in regards to planting and managing trees, you need to understand the livelihood strategies of that household and the historical-social-economic context within which it operates.

B. Complex Social-Ecological Systems

In analyzing livelihood issues and the larger context in which they are found, this study draws on past and recent work in cultural and political ecology, environmental history, and environmental economics that focus on tree-use patterns and practices. These fields offer insights into framing studies that are concerned with complex social-ecological systems (Scoones 1999; Holling 2001; Berkes et al. 2003). Placing this

study in the framework of complex social-ecological systems theory is helpful for a number of reasons. First, it allows for an analysis of the dynamic linkages between social systems and ecological systems. Complex systems theory comes out of general systems theory but incorporates new developments in ecological and social sciences. From general systems theory comes the focus on wholeness – that is, a focus on all of the parts of a system and how they interact and relate to one another. The pieces cannot be understood apart from the whole. This entails attention to the context of the thing or phenomena studied. While general systems theory relied on notions of stability, growth, and predictable successional stages leading to a single climax state; complex systems theory is based on themes of nonlinearity, uncertainty, emergence, scale, and self-organization. These themes have evolved from recent thinking in the science of ecology (Scoones 1999). Systems do not operate in a linear fashion, but rather can go any number of directions depending on the factors present at any one time. This entails a level of uncertainty and unpredictability. In ecology, this means that systems are continuously changing and have many stable states not just one predictable climax stage.

1. Resilience

Over time, new properties will emerge in a system. These new properties cannot be predicted from analyzing a system, but rather emerge spontaneously and add the element of surprise. This is to say that systems are open and self-organizing. A key emergent property of a system is resilience (Holling 2001). Resilience "absorbs change and provides the capacity to adapt to change" (Berkes et al. 2003:6). Resilience defines the amount of change a system can endure before it has to reorganize. When the limits of resilience are reached, a system will reorganize itself

into a new configuration. Resilience is important in understanding social-ecological systems because it allows for an analysis of change – how groups adapt to and absorb change. There are three main components of resilience. Diversity in both social and ecological systems is the first aspect. In general, the more diversity a system has the better able it will be to cope with crisis and change. Diversity spreads risk by not having all of ones eggs in one basket. Related to diversity is redundancy. Redundancy means having more than one component in a system performing similar functions. If one component fails others will be able to perform its same function and therefore protect the system from crisis. Memory is the last component of resilience. Memory is the "accumulated experience and history of the system, and it provides the sources for self-organization and resilience" (Berkes et al. 2003: 20). Memory provides the base from which a system responds to change.

Livelihood strategies and security help to determine a group's resilience (Berkes et al. 2003). This is important for the present study because it helps to explain the livelihood strategies of the Saraguros. Their livelihood strategies have changed over time in ways that could not have been predicted. Over their 1500 years in the basin, the inhabitants have encountered a number of forces that have changed how they utilize the land. But despite these forces they have maintained a level of resilience which today allows them to be recognized as a distinct indigenous group.

2. Spatial Dynamics

Within social-ecological systems, present-day patterns, practices, and processes need to be considered in terms of space and time. Spatial dynamics can be view in terms of scale. Social-ecological systems operate on multiple scales simultaneously. Scales can be understood as nested hierarchies where, like concentric circles, smaller

scales are found within larger ones. In social systems scale can be understood on the level of household, community, region, nation, or world. In ecological systems, scale can be seen on the level of field, farm, local watershed, larger regional watershed, eco-region, or hemisphere. Of particular interest to the present study is the field or farm level spatial distribution of trees on the landscape. First, this includes where land-use systems occur on the land and second, how trees are arranged within these systems. When trees make up the entire use of a system they are considered forestry systems but when trees make up only part of a land-use systems they can be classified as agroforestry systems. Agroforestry will be discussed in more detail below.

Social-ecological systems will be influenced by factors from all these different scales and therefore an analysis must be able to incorporate factors and influences from multiple scales. In Saraguro it is important to understand how the basin fits in with the larger regional watershed and its place within the Andes mountain range. Socially, community level dynamics operate within county, province, national, and international contexts. Elements from these larger contexts have influence the people of Saraguro at different times. As will be seen in the context section of this paper, national programs of modernization and international aid organizations played large roles in household livelihood strategies.

3. Temporal Dynamics

While scale is concerned with the dynamics occurring in the spatial realm (from local to global), the temporal dimension is also important in understanding social-ecological systems. The temporal dimension is necessary for a more complete understanding of present-day situations (Neumann 1992). Current patterns and

processes seen on the land are the result of past patterns, processes, and actors. Recent work on the history of landscape change focuses on understanding social-ecological processes in an historical context (Rocheleau 1995; Batterbury et al.1997). This entails an analysis of the changing interactions between ecological, social, economic, and political processes (Cronon 1983; Hurley 1995). A key idea that emerges from placing social-ecological systems in a historical context is co-evolution. Social systems co-evolve with ecological systems over time (Norgaard 1994; Norgaard and Sikor 1995). This allows for the environment to be understood as both the product of and setting for human interactions (Scoones 1999). Social and environmental change are closely linked – with each affecting the other. In Saraguro, the biophysical factors provided the parameters for the possible range of livelihood strategies and within those parameters, a number of different livelihood strategies have been employed. Each of these different strategies affected changes on the landscape, although some more than others. It is through an understanding of these dynamic interactions that present day patterns and processes become clear.

4. Institutions

In the social realm of this framework, institutions stand out as being particularly important for this study. Recent work in political ecology provides a nuanced view of institutions and their role in natural resource work in developing countries (Zerner 1996; Agrawal and Gibson1999; Leach and Fairhead 2000). At their most basic level, social institutions are "sets of formal and informal rules and norms that shape interactions of humans with others and nature" (Agrawal and Gibson 1999:647). Formal and informal institutions exist at the local, regional, state, and international

levels. Formal institutions can be anything from a community governing council, to a federal government, to an international NGO. Informal institutions can be a community, an ethnic group, or citizens of a country. Social institutions are important because they are the mechanisms of interaction among and between the various levels described above. Instead of being static, social institutions are dynamic and can change over time in response to social, cultural, economic, or political reasons. Within institutions there are multiple actors with multiple interests and viewpoints (Schroeder 1997; Agrawal and Gibson 1999). This understanding of institutions as multi-stranded; local/global; formal/informal allows a more complete analysis of the dynamic nature of interactions between and within institutions and how these interactions can lead to landscape change. In Saraguro, interactions between communities, county governments, the national government, and international NGOs has led to large-scale landscape changes in the form of reforestation with exotic species.

Inherent in institutions are levels of power and authority. Institutions have different levels of power and authority that change over time. Levels of power and authority can be seen on a continuum – local non-formal institutions usually have lower levels of authority compared to formal state or international institutions. Although this can vary greatly depending on the specific arenas of authority. In terms of landscape change, patterns of authority are often "inscribed on the landscape" (Scoones 1999:495). In Saraguro, this can be seen through households' and communitys' interactions with international NGOs.

In many parts of the world today, NGO's are an increasingly influential social institution (Meyer 1993; Keese 1998; Wunder 2000). This study is concerned with how NGOs transfer resources and ideas to rural areas in the developing world and

how local actors respond (Keese 1998). Saraguro has encountered a number of international NGOs. The 1980's through the 1990's saw considerable NGO activity. Many of the projects initiated during this time were centered on reforestation. Through a transfer of knowledge and resources, international NGOs have influenced species composition and tree patterns in the Saraguro basin.

5. Knowledge Systems

In a discussion of institutions, differing systems of knowledge must be taken into account especially when indigenous/traditional/primitive institutions encounter outside/western/scientific institutions. These terms are used to highlight past and recent thinking in the field of indigenous knowledge studies (Richards 1985; Atte 1992; Altieri 1995; Moller et al. 2004). Much past work has fallen into the trap of dichotomizing indigenous and scientific knowledge (Toledo1992; Sevilla-Guzman and Woodgate 1997). In this trap each knowledge system is separate and distinct; static and stable. This is ultimately unhelpful. Knowledge and meanings are not static or stable but are instead dynamic and varied (Agrawal 1995; Watts 2000). This is true for all knowledge systems whether they are traditional, state sponsored, western scientific, or belong to an international environmental organization. But not all knowledge systems are equal – "power produces knowledge" (Agrawal 1995), which is to say that those with power are better able to legitimize their knowledge. This study recognizes the importance of traditional or indigenous knowledge systems, while understanding that the indigenous/western dichotomy is unhelpful. It is more useful to "talk about multiple domains and types of knowledges, with differing logics and epistemologies" (Agrawal 1995:433).

A key aspect of the encounter between different knowledge systems is how knowledge is transferred between the two. Unequal transfer of knowledge often results when one system of knowledge is backed by a more powerful institution (Agrawal 1995). Knowledge is often transferred though formal or informal education. Knowledge and meaning are produced from multiple sources on multiple scales (local, national, international). These histories and meanings change and are used strategically by various actors for various reasons. They are contested and often times fight for prominence on the local, national, and world stage. This study analyzes the encounter of local knowledge systems with international ones but does not frame the encounter in terms of dichotomies. Both systems are show to have a history, have been influenced from multiple sources, and have evolved.

C. Agroforestry

In understanding tree-use patterns and practices on the household level, a classification system is needed that addresses how trees are incorporated into other land-use systems. The science of agroforestry provides the most useful framework. Agroforestry is a specific type of land-use system where trees are combined spatially or temporally with agricultural crops and/or animals (Farrell & Altieri 1995; Nair 1989). Like all types of agroecosystems, agroforestry includes both ecological and socio-economic elements. The generally accepted criteria for classifying agroforestry systems are: 1) Structure; 2) Function; 3) Socio-economic scale; 4) level of management; and 5) ecological spread (Alcorn 1989; Nair 1989; Altieri 1995). Because of the complex nature of agroforestry systems around the world, these four main criteria need to be further broken down in order to encompass local variations and practices. **Structure** can be further divided into the nature of the components and

the arrangement of the components. The nature of the components can be broken down into 4 basic types of agroforestry systems.

1. Agrosilviculture: Agricultural crops combined with tree crops.
2. Silvopastoral: Pasture / animals combined with trees.
3. Agrosilvopastoral: Agricultural crops combined with pasture / animals combined with trees.
4. Other: Specialized systems such as apiculture, aquaculture, or multipurpose tree lots.

The arrangement of the components is in relation to either **space** (mixed, strip or boundary) or **time** (coincident, concomitant, overlapping, sequential, and interpolated).

Function can be broken down into productive functions (food, fodder, firewood, etc.) and protective functions (windbreaks, soil conservation / improvement, shade, and moisture conservation).

Socio-economic scale refers to the cost / benefit relations and the extent to which the system is integrated into the market economy (subsistence, intermediate, or commercial).

Level of management is based on the level of input and technology used in the system (low, medium, or high input).

The **ecological spread** refers to the agroecological zone the system occupies, its scale, and its distribution over the landscape.

Nair (1989) differentiates between an agroforestry system and an agroforestry practice. According to Nair, a system consists of specific practices in an area. He says that:

> Any of these practices can become an agroforestry system when developed or spread to such an extent in a specific local area as to form a distinct land utilization type in that area (Nair 1989:122).

I find this separation of systems and practices cumbersome and unnecessary. I prefer to use system for all types of agroforestry and use ecological spread to group the systems according to their scale or spread over the landscape. The classification

framework outlined above is sufficiently detailed to differentiate between the various scales of agroforestry systems. This framework can classify an agroforestry system on the smallest scale possible (a tree and crop and man) or can classify the system on a field scale or a farm scale; going upwards to classify systems on a village, watershed, regional, or national scale.

D. Theoretical Framework

The above section highlights a number of issues important to this study. Agroforestry classifications, livelihood strategy studies, and literature on social-ecological systems all inform this study. But only the relevant aspects will be used as a guiding framework. First, the classification system of agroforestry is used to understand the types and distribution of tree incorporating systems, the species and their uses, and the social-economic-ecologic scale of the systems. Second, the livelihood strategy approach is used to understand the themes and patterns uncovered in the analysis of agroforestry practices at the level of the household.

1. Types and Distribution of Systems

As stated in the introduction, the first objective of this paper is to understand the types and distribution of tree incorporating land-use systems. This entails a classification scheme. Agroforestry provides the best framework for classifying these systems (Nair 1989; Altieri 1995). First, I classify these systems according to their ecological spread and structure. The main scale of analysis in understanding the agroforestry systems is at the level of individual land-units or parcels that make up the entire resource base of the household. The land-units are named according to the

classification scheme of the landowners and fall into the three main structural classifications of agroforestry – agrosilviculture, silvopastoral, and agrosilvopastoral (Nair 1989). For the sake of simplicity I include the forestry classifications of plantation and native forest within agroforestry; because, although on the level of the land-unit they are not technically agroforestry systems, when seen in the context of the whole farm they are. The arrangement of trees within these broad classifications is dealt with mainly in terms of space. Trees are arranged randomly or in either lines or groups. The function of the agroforestry system is concerned with the use of the trees. The uses are divided into productive and protective functions (Nair 1989). I do not deal with the level of management because the level of input and technology used in these systems is relatively low. I deal with socio-economic scale in terms of livelihood strategies.

2. Livelihood Strategy Approach

Livelihood strategy is a key organizing concept in analyzing agroforestry patterns and practice on a household level (Arnold 1995; Scherr 1995). How a household chooses to pursue a livelihood strategy will often directly influence how and why they use trees. A household's livelihood strategy is best understood by integrating factors from various levels of scale. Livelihood strategies are influenced by a number of factors from the regional, national and international levels (Keese1998; Wunder 2000). I deal with these in terms of social-ecological interactions, history, and local, national and international institutions. Social-ecological interaction allows for an analysis of the dynamic interplay between ecology and society (Norgaard 1994; Hurley 1995). In this context, livelihood strategies develop and respond to the changing interactions between society and the environment. An analysis of the historical context provides a

more complete understanding of present-day livelihood strategies and how and why they developed (Neumann 1992; Rocheleau 1995). Institutions are included here because of their role in landscape change (Zerner 1996; Leach and Fairhead 2000). Of key importance to this study is the encounter between local and non-local institutions and how each adapt and change as a result of the encounter. One aspect of this is how knowledge is transferred.

On the smaller scale, a number of factors influencing livelihood strategies have been identified (Arnold 1991; Warner 2000; de Haan and Zoomers 2005). I will deal with only four factors: size of landholdings, key site characteristics, security and self-sufficiency, off-farm employment, and household choices on how to engage the market economy.

III Methods

Ethnographic fieldwork was conducted while I was a Peace Corp volunteer in Saraguro, Ecuador between May 2002 and Aug. 2004. This type of research is generally viewed as a strength due to its long term nature which helps to enhance trust levels (Schensul et al. 1999). The ability to live and work in the communities over a twenty seven month period has allowed access into the lives, thoughts, and practices of the community members that otherwise would not have been possible. A level of trust and understanding was gained that helped to increase the degree of truthfulness in the research. The long-term nature of the project also allowed for a deeper and more nuanced understanding of Saraguran life, practices, and politics.

The project is based on multiply data-collection methods. Data was collected in Spanish using four methods: (1) Semi-structured, informal, and key informant interviews, (2) participatory and non-participatory mapping with plant inventories, (3) direct and participant observation, and (4) archival / historical research.

A. Interviews

Semi-structured, informal, and key informant interviews were conducted in eight communities. A total of 47 interviews were conducted in the 8 communities of Illincho (13), Lagunas (6), Gunudel (7), Ñamarin (4), Tuncarta (4), Yucucapa (5), Quisquinchir (5), and the town center of Saraguro (3). 47 were short semi-structured interview and out of those 13 were chosen for the longer interview and mapping exercises. 10 key informant interviews were also conducted.

The communities were chosen based on a number of factors including geography, distance to market, political boundaries, and access issues. All of the communities are in the parish of Saraguro within the Canton of Saraguro. The eight communities

form a rough circle around the town center of Saraguro. From the town center, they vary in distance from a half Km to about 3 Km. Each community has road access, although some are more recent than others and some are paved while other are rough dirt tracks. Due to the complex topography of the basin, each of the communities vary somewhat ecologically due to effects of microclimates. Illincho is the highest at around 2750m while Tuncarta averages around 2450m. Illincho, Lagunas, and Gunudel are wetter than Tuncarta, Ñamarin, Quisquinchir, and Yucucapa. Density of settlements is somewhat related to the quality of the land (Belote 1984). In general, the wetter higher communities have better quality land and therefore higher density levels than the lower dry communities. This study follows the lead of past research in the area in regards to study site (Belote 1978; Belote 1984; Ogburn 2001). My study leaves out a few of the communities included in these others. This was done for a number of practical and logistical reasons. Tambopamba and Oñacapa are more isolated and further from the town center than the other communities. This meant they were harder to get to and they did not fit the characteristics I was looking for in regards to distance from Saraguro.

The respondents were chosen through a combination of purposive, snowball, and convenience sampling. It was convenience in the sense that the communities were entered through one or two contacts. These contacts would then identify others within the community that had the specific characteristics I was looking for (snowball). In this way and through trial and error I built a sample population which reflected a wide range of many of the socio–economic conditions present. These include age, gender, education, household size / number of children, size of landholdings, economic status, profession, contact with NGO, extent of commercial production, and land-use system

types. Out of these initial (short) interviews, longer interviews were conducted to explore in-depth the range of conditions identified.

The interviews and subsequent analysis are based on the level of the household. The household is the most useful level to study for a number of reasons. First, most of the land in the Saraguro basin is privately held. Each household manages their land together even though male and female heads of households own land separately. Because households manage their lands together, it is at the household level where decision making processes are best understood. In almost every case a male or female head of the household was interviewed. In a few cases a younger member of the household was interviewed. Efforts were taken to get roughly equal numbers of male (45%) and female (55%) respondents. Of the 47 respondents, 96% were indigenous and 4% were white. Other key break-downs include: 55% of respondents between the age of 20-49 and 45% between the age of 50-79, 70% of the respondents had had previous experience with an International NGO while 30% had not. 49% of the households were solely engaged in agriculture and cattle raising, while 51% of the households had off-farm employment. 43% respondents had either none or elementary school education and 21% had high school or University educations. Based on the wealth ranking matrixes, 17% were in the high category, 21% were in the middle-high level, 21% were in the middle level, 23% were in the middle-low level, and 17% were in the low category.

B. Maps

The landholdings of those participating in the long interview were mapped. This included first a walk through with the landowner who described the boundaries, tree species, and land-use practices. Quick maps were sketched reflecting ideas,

concerns, and understanding of the landowner. Permission was then granted to come back alone to map the land. In this stage interest was paid to exact size, aspect, slope, and elevation of the land. Every tree and shrub was identified and mapped and any observations pertinent to the land-use system were noted.

C. Participant Observations

Detailed observations and field notes were made during the 27 months living in Saraguro. These observations were continually updated and revised through conversations and informal interviews with community members and further observations. Participant observation refers to systematic observations done while participating in the people's daily lives and activities (Lofland and Lofland 1995). This was made possible through my Peace Corps assignment. I lived and worked in Saraguro for the entire 27 months. I taught in the schools, worked with groups, families, and local government official, and participated in the yearly cycles of *fiestas*. This full emersion offered a unique opportunity to participate in the lives and activities of community members and forge strong bonds of friendship and understanding.

D. Archival / Historical Research

Archival and historical research was also conducted. This entailed a content analysis of pertinent "grey literature" including government documents, internal reports from major NGO's, and census data. Historical data was gathered through key informant interviews and a literature review. The Saraguros themselves have published a number of books, pamphlets, etc pertaining to their culture and history. Three Ph.D dissertations (J. Belote 1984, L. Belote 1978, Ogburn 2001) specifically on Saraguro were also utilized. This was enhanced by Jim and Linda Belote living in

Saraguro for 4 months while I was there. They have been studying Saraguro since 1962 and provided a wealth of information concerning the changes they have witnessed since then. This paper is much indebted to the work and friendship of Jim and Linda Belote.

It should also be noted that my wife Pelah Hoyt was conducting a research project during the same time. Her research on the factors contributing to cloud forest conservation is meant as a companion to this study. Both draw from a pooling of data that each has gathered. Taken together both are meant to illuminate the present day land-use practices, influences from outside organizations, and factors that contribute to landowner decision-making processes. From this it is hoped that recommendations can be made for future development work that is both sensitive to the wishes and needs of the Saraguros while helping to further conservation and sustainable use of remnant cloud forest patches.

E. Method Selection

These methods were selected because they allowed for the triangulation of data. The results from each method can be checked and balanced by the results of the other methods. Through this process of triangulation any problems with internal and external validity were reduced. The short interviews allowed for a base line to be developed and to gain an understanding of the patterns, themes, and issues. The long interviews were utilized to gain a better understanding of the emergent patterns. Participatory mapping was used to get out on the land with the landowner to let them define the characteristics of their land and the nature of the map. Solo mapping allowed me to go back and specifically measure the landholdings and how the trees and shrubs are spaced within the landholdings. Detailed mapping generated a pool of

data that was compared with the data gathered from the interviews and allowed for an analysis of any discrepancies between the two. Twenty seven months of personal and participant observations further allowed for a comparison between what people said and what they were actually doing on the land.

Key informant interviews generated in-depth information on specific aspects related to the study. They provided general historical and cultural information along with more specific historical information regarding NGO and Government work in the area. Government officials, community leaders, locals who worked for CARE, and the president of local NGO's were all interviewed. The data gathered from these interviews was then compared with the data generated from archival research. The interviews provided a context in which the specific archival documents could be placed and the archival data helped to illuminate any personal discrepancies / issues of the respondents.

Wealth ranking matrixes were used as a tool to rank the economic status of the respondents using key informants from the 8 communities. In each community (except Illincho) 1-3 key informants were sought who had not participated in the interview process and with whom I had a level of trust built. This was necessary because of the cultural sensitivity regarding questions of wealth status. These informants were then asked to rank all the interview respondents from that community into 3 levels (high, middle, low) of relative economic status. For each respondent the key informants were asked to give the reasons for their choice and were asked to give their overall criteria for each level. Once the 3 levels were established the informants were then asked to further divide the interviewees into 5 levels (high, middle high, middle, middle low, and low). The results from each key informant were compared and averaged with the other key informant answers. In this way a relative wealth

ranking was established for all the interviewees based on community members own criteria. I could not secure any key informants from the community of Illincho. Instead I used all the criteria for wealth ranking given to me by the informants from the other communities and based on the information gathered from interviews and personal observations I place the respondents from Illincho into the five wealth categories.

F. Analysis

Analysis was conducted using grounded theory methods. Grounded theory methods "consist of a set of inductive strategies for analyzing data" (Charmaz 2004). Analysis is "grounded" in the data which is to say that analysis begins with the data and analytical categories come directly from the data not from a predetermined theoretical framework. Charmaz (2004) best summarizes grounded theory:

> The distinguishing characteristics of grounded theory method include (1) simultaneous involvement in data collection and analysis phase of research, (2) creation of analytical codes and categories developed from the data, not preconceived hypotheses, (3) the development of middle-range theories to explain behavior and processes (4) memo making, i.e. writing analytical notes to explicate and fill out categories, (5) theoretical sampling, i.e. sampling for theory construction, not for representativeness of a given population, to check and refine the analyst's emerging conceptual categories, and (6) delay of the literature review (Charmaz 2004. Also see Chamaz 1983 and 1990, Glaser and Strauss 1967, Glaser 1978; 1992, Strauss 1987, Strauss and Corbin 1993).

The inductive nature of this approach allows the themes, patterns, and key issues to emerge organically from the data. Mid-range theories are generated from the themes identified. These ideas / theories are then compared with all relevant literature from any number of fields. Findings from the literature review are incorporated and any issues raised by the literature are addressed. Through this dynamic process of data collection, analysis, theory building, and literature review the researcher is continually

striving to ensure that all findings are thoroughly grounded in the actual words of those studied

IV Context

Figure 1. Ecuador map (Belote and Belote 2005)

A. Setting

Saraguro is located in the southern highlands (Sierra) of Ecuador in the Province of Loja. The Saraguro region is composed of two distinct ethnic groups. One group, living in the town center call themselves *blancos* (whites of Spanish descent); they own most of the shops in town and occupy most positions of power in the local government. The Saraguros are an indigenous group that has lived in the valley at least since Incan times (the 1450´s). The Saraguros live in small communities

surrounding the town center. Their agropastoral livelihood strategy mainly consists of subsistence agriculture and cattle raising (dairy and meat) for income generation although, since the 1970's there has been considerable occupational diversification. The agropastoral land-use types can be divided into three distinct systems:

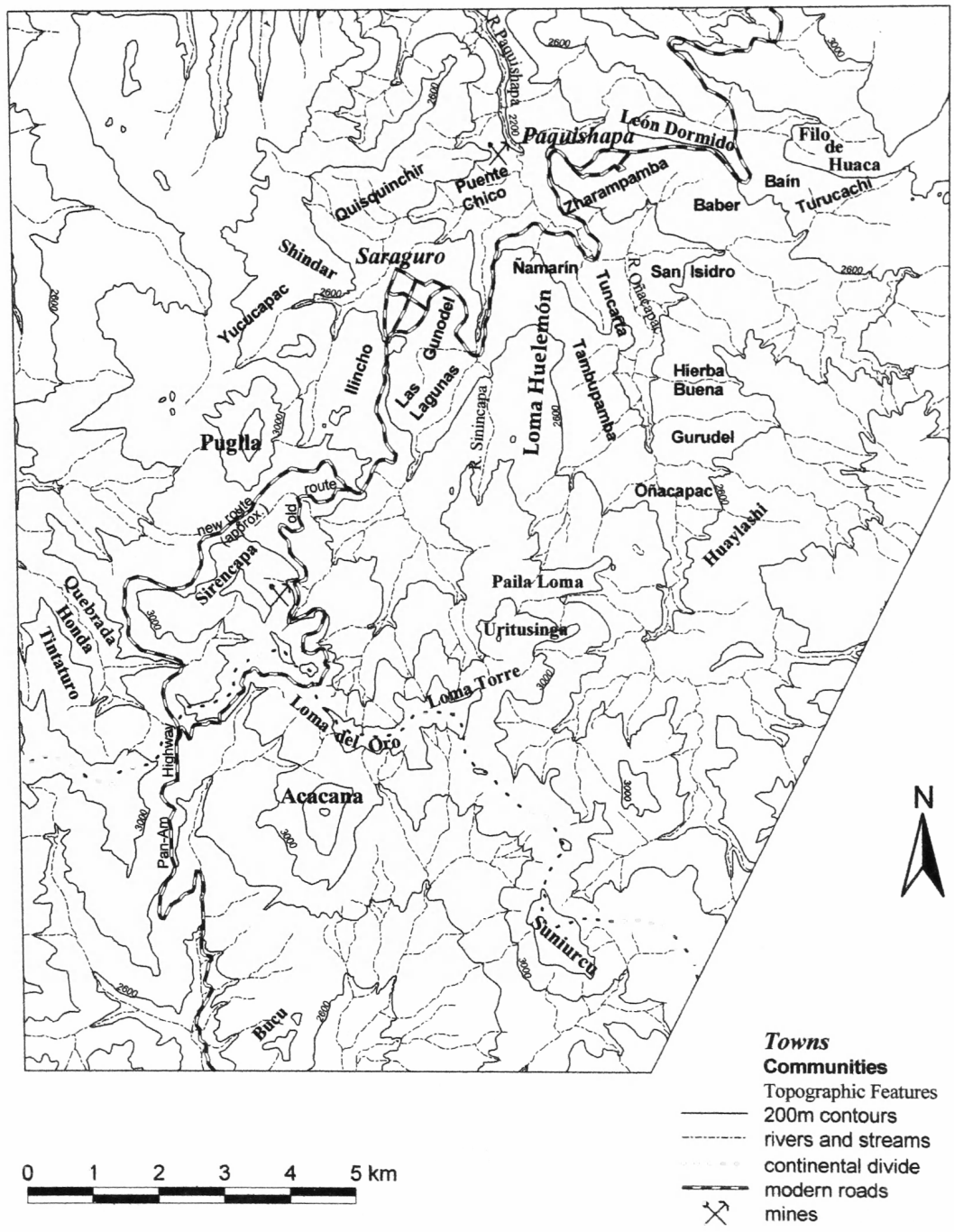
- Homegardens (fruit and multipurpose trees and shrubs combined with vegetables, medicinal and ornamental plants, and/or pasture).
- Field agriculture based on a polyculture system of corn, beans, and squash;
- Pasture systems, sections of which are often rotated with potato crops.
- More recently, fruit production in greenhouses has emerged as a market engagement strategy for a small percentage of the population.

Most land in the basin is privately held with each household averaging between 3-6 hectares distributed amongst 2-10 parcels. These parcels are often widely dispersed often covering two agroecological zones. The two main zones I call the corn zone (2400-2800 meters) and the cattle zone (2800-3000 meters). The distribution of landholdings are the result of inheritance patterns and risk reduction strategies (Belote 1984; Finerman and Sackett 2003). Landholdings are divided evenly among all the children regardless of gender (Belote 1984). But parcels are often swapped and traded among siblings to take advantage of the many microclimate of the area and to reduce the risk of crop failures if one area suffers from drought, frost, or disease (Belote 1984).

Most households raise cattle on land above the communities. Cattle raising is mainly for market engagement through the selling of dairy products and live animals. Bulls are also used to plow fields. Most households raise sheep for the wool products they produce. The Saraguros have a long tradition of textile production (Belote 1984). Historically, households produced their own clothing but more recently, some

households have specialized in textile production to sell locally. Families also keep horses, goats, pigs, chickens, and guinea pigs (*cuyes*). Chickens and guinea pigs are raised for both subsistence and commercial purposes, while pigs are always raised for sale. Horses are mainly used for hauling.

Figure 2, Saraguro Map (by Dennis Ogburn)



B. Ecology

Saraguro sits at 3.5° south of the equator in the Andes mountain chain. The Ecuadorian sierra is itself part of the larger Andes mountain range that runs from Venezuela to Tierra del Fuego. The Andes are commonly divided into three distinct regions: Northern Andes, Central Andes, and Southern Andes (Luteyn and Churchill 2000). The northern and central Andes are considered the tropical Andes and run from Venezuela to northern Chile and Argentina. They are made up of two or sometimes three parallel mountain ranges divided by an inter-Andean valley. The southern Andes are composed of a single range that extends from northern Chile and Argentina to the tip of the continent. Ecologically Ecuador is part of the Northern Andes which run from Venezuela to northern Peru (for a discussion of the characteristics of the Northern Andes see Molina and Little 1981; Luteyn and Churchill 2000). Culturally the Ecuadorian highlands and Saraguro in particular are better understood as part of the Central Andes because of the shared culture and history (Gade 1999).

In Ecuador, the Sierra is generally divided into two distinct regions – the Northern and Southern Sierra. This is due to both geographical and geological differences. The northern two thirds of Ecuador are characterized by a large inter-Andean valley that separates the two main ranges of the Andes. The inter-Andean valley is characterized by relatively large expanses of level ground, river bottoms that are wide and gently sloped, dry (less than 500mm of rain per year), and soils are generally Inceptisols (Southgate et al. 1992). In the northern sierra, the mountains are higher and younger with many snowcapped, active volcanoes. From the city of Cuenca south to the Peruvian boarder, the Southern Sierra is characterized by the absence of a large inter-Andean valley. Here the two main ranges of the Andes run closer

together and form one range just to the south of Saraguro. This creates a complex and rugged geography of small basins and ridges. The basins are generally steep with river bottoms being narrow and steep sided. The mountains themselves are generally lower and are characterized by the lack of snow peaks and active volcanoes. This gives rise to different soils than in the north – mainly Vertisols or Kaolinite clays (Southgate et al. 1992).

Saraguro, then, is situated just north of where the two main Andean ranges come together. This is known as the nudo de Wagrauma (Wunder 1996). Saraguro is located in a small basin at the headwaters of the Rio Paquishapa. The Rio Paquishapa is itself a tributary of the Rio Jubones which empties into the Pacific Ocean just north of the coastal town of Machala. Saraguro sits just below the continental divide at an elevation of a little over 2500 meters. To the south, east and south-west the mountains rise up to the Continental Divide. To the north / north-west the basin drops into a desert region of steep canyons.

The weather in the Saraguro basin is highly variable due to the complex topography of the area. The north is generally dryer and the south wetter. This, in part, is due to elevational differences (the north being lower) and the northern portion of the basin being closer to the desert canyon of the Rio Leon. On average, Saraguro receives between 650 and 900 mm of rain per year. This is distributed unevenly over the entire year. James Belote (1984) describes a triple maxima rainfall phenomenon where the maxima occur during different months in different years. The general pattern is one where rainfall is greatest during February or March; May or June; and October. These three peaks are separated by months of reduced rainfall. With this as the general pattern it should be noted that amount of rainfall can vary considerably from year to year with some years having a double maxima phenomenon.

Temperatures, in contrast, are rather stable throughout the year. The average daily temperature is between 12-15° C.

Three natural vegetation types are found in the Saraguro area: cloud forest (*bosque nublado*), high alpine grassland (*paramo*), shrub land (*monte*). Forests probably once covered most of the Saraguro basin (Belote 1984; Ogburn 2001) but now are reduced to remnants along the Continental Divide. These forests are classified as upper montane forests (Luteyn and Churchill 2000), as montane moist forests (Cañadas 1983), and as montane cloud forest (Aguirre et al. 2002). I will use the simple term cloud forest for the purposes of this paper. In the province of Loja, cloud forests are found between 2300-2900 meters (Aguirre et al. 2002). These forests are characterized by cool temperatures and almost constant cloud and fog cover (Luteyn and Churchill 2000). Cloud forests receive most of their precipitation in the form of mist from clouds (Ataroff and Rada 2000; Luteyn and Churchhill 2000). As a result of the high mist content in the air, epiphytes such as orchids, bromeliads, lichens, and bryophytes are a common life-form (Luteyn and Churchill 2000). These forests play an important hydrological role because they actually increase the amount of water available in the watershed (Bruijnzeel and Proctor 1995; Becker 1999; Ataroff and Rada 2000). The trees are smaller and there are fewer dominant species here than in lowland tropical forests –although plant diversity is still high. An inventory of two cloud forests in the Saraguro region found 75 and 90 tree species per hectare (Madsen and Øllgaard 1994). Some of the dominant genera of the cloud forest are: *Clusia (*Guttiferae), *Weinmannia* (Cunoniaceae), *Schefflera* (Araliaceae), *Vallea* (Elaeocarpaceae), *Myrica* (Miricaceae), Myrcianthes (Myrtaceae), *Drimys (*Winteraceae), along with many genera belonging to the families Melastomataceae and Compositaceae. There are usually two levels to the canopy, the upper canopy

being very dense. Because of the colder conditions, decomposition rates are slow and this in turn gives cloud forests a thick litter layer – in places up to a meter deep (per obs). Cloud forests also have low diurnal temperature fluctuations because the high moisture content in the air acts to moderate temperature extremes.

Above the cloud forest rainfall and temperatures decrease and forests give way to a tropical alpine country know as the paramo. As an ecological type, paramo is only found in the Northern Andes (Venezuela, Columbia, Ecuador, and extreme northern Peru). In the Saraguro region, the paramo begins at around 2900 meters and continues to the peaks of the highest mountains. Two large tracts of paramo exist in the Saraguro region. One tract lies to the west of Saraguro along the Cordillera Chilla. This is the highest area around Saraguro with several peaks just below 4000 meters. To the east and south-east lies the other large tract of paramo along the Cordillera de Tamboblanco and Cordillera de la Paz. Large sections straddle the Continental Divide and it is lower and wetter than the tract to the west. Much of the paramo is naturally occurring but there is still much debate as to how much of the paramo is human caused (Gade 1999). The paramo is the most floristically diverse alpine region in the world (Luteyn and Churchill 2000). Grasses (Calamagrostis and Festuca) are dominant in the paramo although there are many other types of shrubs, sedges, rosettes, and cushion plants (Luteyn and Churchill 2000).

The shrub land, known locally as *monte*, is a vegetation type found only in southern Ecuador and northern Peru between 2000-3000 meters (Luteyn and Churchill 2000). It has the appearance of a disturbed landscape. In Saraguro, *monte* is found in small patches adjacent to pastures and whole hillsides are covered in it –most notable on hills above shindar and on hills to the south-east of Puglla. Some of the main shrub families that make up *monte* are: Asteraceae, Bromeliaceae, Ericaceae,

Melastomataceae, and Proteaceae (Luteyn and Churchill 2000). A number of these shrubs are important to the Saraguros for dyes and medicine.

C. Historical Context

With this short sketch of the ecological setting of the Saraguro region, I will now turn to the exploration of how livelihood strategies have been utilized in this environment. A brief overview of the history of land-use shows how different livelihood strategies utilized the physical environment of Saraguro. This overview demonstrates the complex history of land-use change and how the ecology of the basin has been shaped by human interactions over a long time span.

1. Pre-history

Following James Belote (1984), the pre-history of the greater Saraguro region can be divided into three distinct phases. The first phase begins around 12,000 years ago. It is characterized by groups of nomadic hunters and gatherers. These "paleo-indians" occupied the high paramo country above 3000 meters. These groups probably had an effect on wildlife populations in the area and probably burned forests to increase grasslands but little or no evidence exists at this time to support the claim.

The second phase begins roughly around 2000 BC and continued until around 500 AD (Belote 1984; Ogburn 2001). This phase is characterized by permanent or semi-permanent settlements in the warm valleys between 900-1500 meters. Limited archeological evidence suggests that there were settlements along the Rio Jabones and the Rio Leon (Belote 1984). According to James Belote (1984) and Dennis Ogburn (2001), these groups were horticulturalists and may have irrigated corn crops.

Around 500 AD, livelihood strategies changed radically. Lowland settlements were abandoned in favor of higher elevational niches. This radical shift in land-use strategies can probably be attributed to the appearance of a new group with new technologies, techniques, and agriculture (Belote 1984). James Belote (1984) notes that:

> Modern Saraguros are undoubtedly at least in part descendants of [this group] and it was probably during this phase that patterns and processes of adaptation directly ancestral to those of the region today were established.

This phase is known as the Saraguro Phase (Belote 1984; Ogburn 2001) and is characterized by subsistence groups occupying the ridges and mountain slopes between 2700-3000 meters. This group practices terracing and cleared forest patches for agriculture and settlements (Belote 1984).

The Saraguro phase beginning around 500 AD is the beginning of permanent human habitation in the Saraguro basin. Ogburn (2001) makes a number of observations that contribute to our understanding of this phase of Saraguro history. First of all, the settlement of the Saraguro basin is late compared with other parts of the Andes. This is most likely due to the thick forest cover and lack of flat ground in the basin. Also the Saraguro basin has a colder wetter climate compared to other basins close by. Ogburn believes that the late settlement was probably triggered by increased warfare in the region. This would explain the strategic location of settlements on ridges and steep hill slopes. The increased vulnerability of populations would help to justify the heavy labor demands of forest clearing and terrace building if it meant increased protection. Another observation Ogburn notes is that this group was probably subsistence agriculturalist who also practiced camelid herding. A question of interest here is, did they only farm close to their settlements utilizing the terraces or did they also farm lower down the basin? If they mainly farmed close to

settlements did they mainly grow tubers? And if they grew crops down lower, what did they grow?

2. Incan Occupation

The Saraguro phase continued until the 1450's when the Incan army led by Topa Inca son of Pachacuti invaded the area (Ogburn 2001). The brief sketch of the Incan phase in Saraguro that follows is taken from Dennis Ogburn's (2001) dissertation "The Incan Occupation and Forced Resettlement in Saraguro, Ecuador".

The Incas quickly gained control of the area and set up a number of administrative, storage, and religious sites. The main north-south road was constructed through Saraguro. This road connected the capitol Cuzco in the south with Tomebamba (what is now Cuenca, Ecuador). Tomebamba was to become the second most important city in the Incan Empire and base of operations for the northern part of the empire. It is also probable that the Incan removed most of the former inhabitants of Saraguro and replaced them with other groups from other parts of their Empire. The practice of forced resettlement was a common Incan practice and has been documented elsewhere (Ogburn 2001; D'Altroy 2002). As is a common practice with invasions of Empire, the Incas brought with them their own language and religion. From the archeological evidence in the area, Saraguro appears to have been an important center. Ogburn (2001) maintains that Saraguros importance stems from its strategic and religious role rather than an economic one. It was strategic because the Incan Empire bottlenecked in the Saraguro area – meaning that the Incas did not have control of the land to the east or west of the Andes but only controlled a narrow corridor in the Sierra. So if Saraguro was overrun, the northern part of the Empire and Tomebamba in particular would be cut off from the capitol. The religious significance

of Saraguro stems from its association with Tomebamba as being sort of the entrance to the region.

The Incan occupation in Saraguro lasted only about 100 years before being replaced by the Spanish occupation. The Incan occupation can therefore be seen as the first in a series of encounters with Empire. The Incas are the first to introduce Saraguro to the politics and economics of the State. It is in the 1450's that Saraguro ceased to be a relatively isolated basin dealing mainly with regional issues that it was previously. The Incas effectively connected Saraguro with Cuzco and Cuenca and made it one of many way stations.

3. Livelihood Strategies Under the Incas

The Incan occupation of Saraguro is important to this study because it induced a change in livelihood strategies and introduced new elements into the Saraguro basin. Local livelihood strategies and local forms of governance were subsumed into the larger context of State policies and agendas. With the Incan State came a whole bundle of new practices, technologies, and ideologies. Archeological evidence suggests that the Incas occupied locations further down the basin mainly between 2400-2700 meters, while allowing the previous inhabitants to continue living in their higher settlements (Ogburn 2001). It is not known if corn was previously raised in the area but it is highly probable that the Incas elevated the status and increased the production of corn in the area. Corn was a highly sacred component of the Incan Empire and figured significantly into their culture and practices (D'Altroy 2002). It is likely then, that the Incas cleared land for corn production. In this context, livelihood strategies cannot be seen as purely subsistence. Under the central state, food and other goods were collected from every part of the empire and were stored and

distributed (D'Altroy 2002). With its mainly strategic and religious significance, Saraguro may have only produced enough food for itself or it may have relied on food grown elsewhere in the empire. It can be assumed that with the Incan occupation there were changes in livelihood strategies. Local livelihoods were subsumed under the centralized state. Access and control over land and other resources were most likely controlled by local administrators acting on behalf of the State. Saraguro was integrated into the larger economy of the Empire and every aspect of life came under the direct control of the State and its institutions.

Much has been written about tree use and management by the Incan Empire (see Ansión 1986). Firewood gathering was regulated where wood was placed in storage facilities for redistribution (D'Altroy and Hastorf 1986; Johannessen and Hastorf 1990). Trees were planted and managed as part of other land-use systems and several tree species were purposely cultivated in regions where they did not originate (Gade 1999; Chepstow-Lusty and Winfield 2000). It is hard to say for certain what the Incan practices relating to trees were in the Saraguro area, but it is likely that they may have brought species from other regions. Gade (1999) lists some of the trees that could be possible candidates for Incan introduction are: Molle (*Schinus molle*), Willow (*Salix sp*), Guato (*Erythrina sp*), Aliso (*Alnus sp*), Quishuar (*Buddleja sp*), Luma (*Pouteria sp*), Cherimoya (*Annona sp*), and San Pedro (*Trichocereus sp*). So while little can be known for certain with regards to specific tree-use practices of the Incas in Saraguro, it is highly probable that they had an influence on species distribution

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4. Spanish Occupation

The Spanish had complete political and military control of Saraguro by the late 1500's (Belote 1984). And like the Incans before, they set up their own systems of

administration, trade, agriculture and livestock, religion, and social structure. Saraguro never figured prominently in the Spanish colony. Most likely this is because of Saraguro's distance from other colonial hubs, its thick forest cover, its cold and wet climate, and its lack of gold or other minerals (Belote 1984). The Spanish were not interested in the land resources of Saraguro but they were interested in the labor and tributes they could offer to the Crown. The Spanish continued to use the transportation networks set up by the Incas and enlisted the Saraguros to maintain a way station. This *tambo* service forced the Saraguros to provide food and shelter to government officials and their animals and they had to maintain pack trains to haul goods for the government (Belote 1984). This service meant that they had to provide food and pasture beyond a purely subsistence basis. To provide this service also meant that they needed access and control over a large land base resource. It was the value the Saraguros provided the Spanish through the tambo service that ultimately allowed them secure land tenure. James Belote (1984) documents a 1718 land dispute case where the indigenous land owner successfully argued his case against a non indigenous claimant. The argument was based on the idea that in order to successfully run the tambo service, a land base was needed. The Saraguros were more valuable to the government as a source of free labor than they would be as property of a large hacienda. Because of this the Saraguros were given sufficient protection to maintain their land base from outside threats.

Besides introducing a new religion, the colonial era brought with it new forms of livestock. Sheep and cows were incorporated into the Saraguros livelihood strategies and have become an important part of their culture (Belote 1984; Gade 1999). Other colonial era introductions important in the Saraguro basin where: horses, goats, pigs, wheat, barley, agave, and the tree capuli (*Prunus serotina*). Metal tools made forest

clearing and firewood gathering easier. And the Mediterranean scratch plow combined with the increased animal power bulls provided allowed the Saraguros to begin plowing their fields.

5. Changing livelihood Strategies after Independence

Ecuador gained its independence from Spain in 1830 to become its own sovereign country. This fact had little effect on how the "State" dealt with the Saraguro indigenous group. The Saraguros still maintained the tambo service and still held on to their landholdings. By this time, the town center of Saraguro had a large non indigenous population and by the mid 1900's there would be few indigenous left in the town of Saraguro (Belote 1984). Instead, they were congregated in small communities around the basin.

What follows is a history of the Saraguros from around 1900 to the early 1980's based on James Belote's (1984) study of the changing adaptive strategies of the Saraguro indigenous group. Jim Belote's study critically examines the adaptive strategies of the Saraguro indigenous group in relation to outside forces and highlights the Pan American Highway as the factor having the largest impact on the Saraguros livelihood strategies. His research is used as the point of departure from which this study is launched. What follows is a summary of James Belote's main findings.

In the beginning of the 20th century the Saraguros were engaged in a subsistence agropastoral existence. They lived in a relatively isolated area with no roads or regular market. They were only minimally involved exchange transactions with other ecological zones (mainly the coastal lowlands). The Saraguros raised cattle and chickens to use as exchange for salt, metal tools, rice, and tropical fruits. The tambo system of forced labor was still required of the Saraguros. This holdout from colonial

times continued to put heavy land and labor requirements on the Saraguros. They had to produce surplus food to feed travelers and had to maintain and drive mule trains.

This way of life changed in the 1940's with the completion of the Pan American Highway between Cuenca and Loja. James Belote (1984) maintains that "**the single most important event in the history of Saraguro economy was the construction of the Pan American Highway in the 1940's**". These changes included:

- The end of the forced *tambo* service.
- The development of a weekly market in Saraguro and Saraguro becoming the main commercial center for the Canton.
- The intensification of cattle raising for the market economy.

With the completion of the Pan-Am Highway, the Saraguros developed a **dual strategy** of increased market engagement while retaining their subsistence base (Belote 1984). Motorized transport effectively opened the markets in Cuenca and Loja and a weekly market was established in Saraguro to sell regional produce and livestock. Because of these new opportunities the Saraguros began raising more cattle to increase their participation in the market economy. They were able to do this because of their relatively large secure land holdings. James Belote (1984) notes that in the 1970's the average Saraguro household (3-6 people) owned 15-30 hectares of land. While increasing their engagement in the cash economy, they also maintained their subsistence agricultural base.

This dual strategy of market engagement combined with a subsistence agricultural base has defined the Saraguro's adaptive strategy from the 1940's into the present (Belote 1984). The adoption of this dual strategy led to significant changes in land-use practices and subsequent changes in landscape vegetation patterns. The change

from relatively low numbers of free-range cattle in the high alpine grasslands to raising larger numbers of cattle in a managed pasture system is responsible for most of the changes in landscape vegetation patterns.

Raising cattle for the market economy made it necessary to keep cattle closer to primary settlements. Keeping cattle in the high country made it highly impractical if not impossible to obtain milk and cheese on a daily basis. But the only land available for conversion into pasture was the forested land above the intensively managed cornfields surrounding the primary settlements. Market engagement made it economically feasible for most households to invest in the large amounts of labor needed to clear and burn the forests for pasture. Beginning in earnest in the 1940's, Saraguros started clearing this land for pasture (Belote 1984). Forests were cleared in areas above primary settlements anywhere from a half hour to three hours walk. The land chosen had to have a number of characteristic for it to be suitable for cattle raising. The pastureland needed to be near a water source but also needed to be sloped to allow for proper drainage due to the large amounts of rainfall the Saraguro area receives. Once the land was cleared grasses had to be sown. Since all of these pastures were privately held, landowners usually left trees and shrubs along the perimeter to mark the boundaries of their field. Instead of fencing the pasture the Saraguros tethered each animal. In this highly managed system, cattle had to be moved to new pasture and watered up to two times a day (Belote 1984). The widespread use of this system resulted in the deforestation of most of the lands surrounding primary settlements.

The subsistence aspect of the dual strategy was a polycultural agriculture system of corn, beans, and squash located close to the household. Potatoes were grown in the higher country usually in rotation with pasture. In homegardens they also grew: a

few vegetables, pasture grasses, medicinal and ornamental plants combined with fruit trees. The Saraguros agricultural production system is oriented towards security maximization. Since most agricultural products are produced for subsistence needs, the agricultural system is based on food security and diversity throughout the year. But James Belote (1984) also notes that "Saraguro agricultural production is characterized by a degree of variation within broad constraints. Saraguros are not bound by traditional systems, but within limits of time, land, and money are quite ready to try new techniques".

In his conclusion, James Belote (1984) notes that the dual strategy was reaching its limits by the late 1960's and that population growth was catching up with the availability of good land. This, he says, has led to a number of responses by the Saraguro people. One of the most important responses to note is the colonization of the lowlands to the east for cattle raising. Other responses to lack of land have been the intensification of land already in use and occupational diversification. These responses are helping to prolong the use of the dual strategy by lessening pressure on land resources (Belote 1984).

Jim Belote's study examines the adaptive strategies of the Saraguro indigenous group in relation to outside forces. He highlights the Pan American Highway as the factor having the largest impact on the Saraguros livelihood strategies. The Saraguros became more integrated into the market economy through changes in their cattle raising strategies, yet they maintained their traditional subsistence base. This was possible because they had access to and control over a large resource base in the basin. It was shown that they were able to keep their land base in spite of pressures from outside forces because of State protection. They provided the *tambo* service to the government which required large landholdings. Yet, this is not to say

that they were not marginalized in other ways. While they owned most of the land resources in the basin and were overall better off than the town whites, they were still marginalized in the political and social spheres (Belote 1978). The Pan American not only brought an increase in market engagement and outside goods but also an influx of whites. By the late 1940's there were no indigenous living in the town center of Saraguro (Belote 1978). The Saraguros marginalization can be seen in terms of space (they occupied the periphery) and in terms of involvement in local government and State institutions. It is not until the 1990's that Saraguros held positions in the local government. Saraguros were also marginalized in the State education system. It was only in the mid 1970's when indigenous were allowed to attend high school as indigenous – if they wanted to attend before this time they had to transculturate (cut their hair and dress like a white). Socially they were near the bottom; whites could talk down to them, while they had to act respectfully and they were force to ride in the back of buses (Belote 1978).

6. Livelihood Strategies from the 1970's to the Present

This was beginning to change in the late 1970's and early 1980's. Ecuadorian society was becoming more open. High schools and universities were accepting indigenous populations (Macas et al. 2003). This along with other events at the State level allowed Saraguros to seek other types of livelihood.

In Ecuador, the 1970's saw the beginning of large scale oil exportation. This had wide ranging affects throughout the whole country (Southgate et al. 1992; Wunder 2000). While significantly increasing Ecuador's GNP, it also made Ecuador eligible for international loans. The State used this new wealth in three ways: (1) Further integrate the *costa, sierra*, and the *oriente*; (2) increase growth rates and subsidize

industrialization; (3) develop infrastructure and improve living standards (Wunder 2000). In Saraguro, this modernization scheme brought electricity to the communities, a hospital in town and health clinics in the communities, and new schools. Cooking gas subsides made propane stoves much more affordable and they began to increase in importance as a cooking fuel option. As households obtained gas stoves, their dependency on firewood was significantly reduced. The modernization process also increased wage labor salaries while keeping agricultural prices the same. This made it much more profitable for Saraguros to seek employment off the farm. From the 1970's until today there continues to be a steady migration from rural to urban settings (Census data).

Forest conversion to pasture continued in Saraguro through the 1970's and 1980's, although the rate of conversion was slower than it had been previously. By the early 1980's the landscape was very different than it had been just 40 years before. Most of the forests in the basin had been converted to pasture land. Forests remnants were reduced to the high steep areas straddling the Continental Divide. This rapid and widespread change needs to be understood as the result of economic and social factors. The Pan American highway opened new markets, but this alone is not responsible the rapid landscape change. It was the result of individual household's deciding to engage the new markets through an intensely managed cattle production system. And this was an option only because the Saraguros had a land resource base that could support this new activity. So, it was a combination of economic, social, and historical factors that led to the landscape level change from forest cover to a mosaic of privately owned pasture bordered by hedge rows of native trees and shrubs that had been left as boundary markers.

This reduction in wood supplies did not go unnoticed. Wood for houses and firewood were becoming harder to obtain. People had to travel greater distances to secure their needs. A landowner recalls this time in the late 1970' and early 1980's, "Back then it was like a desert here. There weren't any trees or firewood" (1105). Another person recounts this story about a community above Yucucapa:

> *I remember my Father would tell us this story about when he was building a house. He had to go up into the hills with his bulls to bring back wood for the house. To bring back small trees it would take a full day, but to bring back big trees it would take my Father two full days. It took him almost two years to build the house* (2308).

7. Institutions and Landscape Change

Into this context came an increasing number of State agencies and international development organizations with reforestation programs. The first, beginning perhaps as far back as the mid 1960's planted some eucalyptus (1304). Then came CARE and the Ecuadorian Program for the Development of the South (PREDESUR). Both of these organizations began planting pine and eucalyptus on community land. Other organizations to initiate reforestation or fruit tree projects in the 1980's and 1990's have been the Ministry of Agriculture and Livestock (MAG), Peace Corps, and PLAN International, and a number of local NGO's (Foundation Kawsay, Foundation Kullky Yaku, and project Saraguro/ Yaquambi).

The efforts of these organizations in participation with a number of local actors have transformed the landscape of Saraguro yet again. There are now over 1000 hectares of pine plantations in the area (CARE 1996a), eucalyptus groves cover almost all land not used in production, a number of introduced trees line property boundaries, and new types of fruit trees have been incorporated into homegardens. The landscape has been so transformed that it can be termed an NGO landscape

"meaning visible features on the land showing the effects of NGO work" (Keese 1998:464).

As has been shown, the landscape and people of the Saraguro basin have co-evolved over the last 1500 years. The landscape of today is, in part, a product of human action. It has been shaped by historical, social, and economic factors. In the beginning of the 21st century, the landscape continues to co-evolve with human and non human actors. National and international institutions are still working in Saraguro but not to the extent that they were in the 1980's-1990's. That period can be seen as the heyday for national and International reforestation efforts. The organization CARE took the leading role, working in more communities (24), for a longer time (13 years), and initiating more reforestation and agroforestry projects than all the other agencies and organizations. CARE left in 1996 after they had fulfilled their objectives and their projects were self sustaining (CARE 1996b). Since that time, some of the projects have been abandoned, some have fallen into disrepair, many are being maintained, and some have been expanded upon. Without CARE's continuing intervention, these projects have taken on a life of their own. The Saraguros have taken these projects and made them their own. Through a process of using and discarding elements of these projects that they like and dislike, they have incorporated these new practices and technologies into their pre-existing systems. In investigating how livelihood strategies influence farm tree and agroforestry practices, this study critically examines CARE's work in Saraguro. It will not only look at how CARE influenced land-use change but also how the households of Saraguro have incorporated these projects into their pre-existing systems.

V Findings

This section is divided into three main parts. The first part uses the agroforestry classification system to classify the individual land-units. This includes the types and distribution of agroforestry systems, the species present and their uses, and how the differences found within systems reflects differences in livelihood strategies. The second part will show how livelihood strategies affect tree-use at the level of the household. Livelihood strategies will be explored from multiple levels of scale and history. The last part will examine the role CARE played in influencing tree-use patterns and practices through the introduction of new species and the dissemination of their technical and environmental knowledge.

A. Types and Distribution of Agroforestry Systems

This section begins with a general overview of the types of systems found including species and their uses. Then, each land-unit type will be discussed in-depth.

The tree incorporating systems found in the Saraguro basin can be broadly classified as five main types or systems. (1) agrosilvoculture, (2) silvopastoral, (3) agrosilvopastoral, (4) plantations, and (5) native forest / shrub land. The first three are agroforestry classifications (Nair 1989). Technically, number (4) and (5) are forestry classifications but I will consider them as agroforestry classifications based on the whole farm perspective (see theoretical framework for explanation).

The entire land base of a household was found to average 3-6 hectares (ranging from half a hectare to 15 hectares) and made up of between 2 and 10 separate parcels or land units. These land-units were non-contiguous (sometimes an hour or more on foot) and varied greatly in elevation and other biophysical aspects. I refer to each of these separate land blocks as land-units or parcels, while the total

landholdings of a household are referred to as the entire land base, entire resource base, or farm. Second, I use system in two different ways. A land-unit as a whole is seen as a system and includes all the components found within each unit of land. The components within each parcel are also referred to as systems or sub-systems – they are the individual agroforestry systems found on any land unit. It is necessary to differentiate between these two usages because they represent differences in scale. It is important that the land-unit itself be viewed as a system for two reasons. First, the landowners view each separate parcel as self-contained. Each parcel must be visited separately and is managed as a unit. For example, a unit may contain a pasture, a cornfield, a vegetable garden, and a wood lot. Second, each of the components within the land unit interact with one another. Using the example from above – tree branches from the wood lot might be used to make a fence around the vegetable garden, manure from the animals in the pasture could be applied to the cornfield, and the cornstalks many times are fed to the cows. So from the perspective of the landowner and because of the many interactions between the components within a unit of land, it makes the most sense, conceptually, to treat the land unit as the system. These systems fall under the three agroforestry classification types: agrosilvocultural, silvopastoral, and agrosilvopastoral and the two forestry classifications of plantation and native forest / shrub. Then moving down a level, each of the various components within the land unit are themselves individual agroforestry sub-systems. Example of this level of classification include: homegardens, wind breaks / living fences, and tree gardens.

Landowners in Saraguro classify their land-units according to what they see as its main function. The five main classifications are: (1) Residence (*terreno alrededor la casa*), (2) field agriculture (*chacra*), (3) pasture (*potrero*), (4) plantation (*plantación*),

(5) native forest or shrub land (*bosque nativo, montaña, or cerro; monte*). Within these five land-unit types, trees are arranged in various ways. The table below shows how trees are arranged in each of the five land-unit types:

Figure 3. Tree Incorporating Land-Units

Type	Components
Residence	• Homegardens • Hedge rows / living fences / wind breaks • Randomly spaced fruit / multipurpose trees • Orchards • Greenhouse
Field Agriculture	• Hedge rows / living fences
Pasture	• Hedge rows / living fences / wind breaks • Dividers • Randomly spaced fruit / multipurpose trees • Multipurpose woodlots • Native forest / shrubs
Plantation	• Evenly space rows of trees
Native Forest / Shrub	• Native trees / shrubs

In many cases two or more of these classification types were found to coexist on the same land-unit. Where this occurred, the landowner usually classified it by what they perceived as its main function even if the perceived main function was not the dominant land-use in terms of space occupied. The residence classification proved to be somewhat problematic. In all cases the residence land-unit contained the homegarden. When describing the homegarden, some respondents listed trees or shrubs that were not technically within the homegarden but rather within the larger residence land-unit. Efforts were taken to minimize this but within the short interviews there was some overlap between the two. The percentages in the following section

are based on the 47 households that participated in the semi-structured interviews pertaining to their landholdings.

1. Species

59 woody species (trees, shrubs, and cacti) were identified in the land-use systems of the Saraguros (see appendix for complete list of species and uses). According to local classification systems, these woody species can be divided into a number of different overlapping categories. The most general differentiates between a tree (*árbol*) and a shrub (*arbusto*). The tree category is often broken down into native trees (*árboles nativos*), introduced or exotic trees (*exóticos*), and fruit trees (*frutales*). The native tree category includes a number of native forest species but also includes a number of trees that were brought to Saraguro by human agents. These include, guato and cañaro (*Erthyrina spp.*), capuli (*Prunus sertina*), and aliso (*Alnus spp.*). Guato and cañaro were probably brought by the Incas (Gade 1999). Capuli was most likely brought by the Spanish and aliso was brought more recently mainly by CARE. The exotic tree category includes more of the recent arrivals (1970's and on) brought to Saraguro by international NGOs and Government ministries. The three main exotic species include: eucalyptus (*Eucalyptus spp.*), pine (*Pinus patula* and *P. radiate*), and acacia (*Acacia spp.*). The fruit tree category includes a mix of native and exotic trees. Many of these trees must have come to Saraguro at various times but I was not able to find when and under what circumstances they were introduced – these include: avocado, babaco, cherimoya (*Anona sp.*), granadilla, lemon, luma (*Pouteria lucuma*), raspberry, and orange. In the early 1980's CARE and Plan International brought apple, pear, peach, and plum to Saraguro as part of their improved fruit tree garden projects.

2. Problems Associated with Tree Species

A number of problems associated with tree-use were identified. 72% respondents said that certain species of trees dry the land. The main culprits identified are: eucalyptus (82%), pine (47%), acacia (26%), capuli (9%), and cipre (9%). An almost universal response was – "*Pine and eucalyptus dry the soil*" (5101). A strategy to overcome this problem was to plant them far away from land under production. One informant told me,

> *Eucalyptus absorbs the nutrients from the soil and dries the soil also. But you just have to look for certain places to plant them. You have to plant eucalyptus in places that cannot be used for crops*" (1108).

Another problem associated with drying the land is that certain trees were said to take all the nutrients out of the soil. Pine, eucalyptus, and acacia were given as the trees that take the most out of the soil. When asked if she had problems with any trees and if so what trees one respondent replied,

> *Non native trees like pine, acacia, cipre, and eucalyptus absorb all the minerals from the soil – they eat everything*" (7104).

9% said that leaf litter from pine and eucalyptus prohibits understory growth. In the words of one respondent, "*Pine needles kill everything below the tree -- the needles fall and cover the ground and nothing can grow"* (1105). Other problems identified were that trees take up too much space and the shade produced by trees has negative impacts on crops and pasture. A number of problems were identified dealing with the management of fruit trees. These include disease, bird and insect pests, and problems associated with the elevation (just too high to produce good fruit).

3. Uses

The uses identified can be organized into either productive or protective functions. The productive uses identified were: ornamental (*ornamentales*), fruit/food

(*fruta/alimentación*), firewood, medicine, dye, forage, construction/wood, furniture, posts (*postes*), tools (*herramientas*), and commercial (*para vender).* The protective functions identified were: windbreaks *(cortinas* rompevientos), living fences (*circas vivas*), maintain humidity (*mantiene humedad*), nitrogen fixing (*fijador de nitrógeno*), fertilizer (*abono)*, filtration, shade (*sombra*), and soil conservation/erosion control (*conservación del suelo/evitar erosión*).

a. Productive Uses

Of the 47 respondents, nearly all related the overall importance of trees to the productive function they served. 51% respondents listed firewood as a tree's primary importance. 49% of respondents named construction material as one of the most important uses of trees. 36% respondents said the primary importance was fruit production, 17% said for medicine, and 4% said for use as dyes.

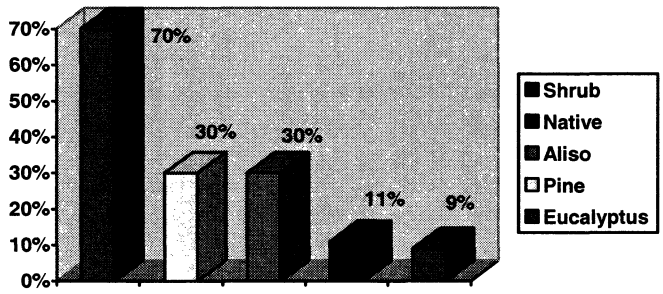
Firewood use for cooking was still common in all of the communities I worked in. All 47 households use wood for cooking to some extent. These eight communities all have roads and are close to the city center so cooking gas is an option. And in fact 42% of respondents said they used gas more often than firewood. 30% said they use gas and firewood about equal, while 28% said they use firewood more often. Given these numbers it can be seen that firewood use is still prevalent. Its use is important for cultural and economic reasons. One of the main traditional dishes of the Saraguros is hominy (*mote*). These are dried corn kernels that require many hours of boiling to prepare. All respondents said they like to cook mote over the fire because this is how it was traditionally done and it tastes better. They also noted that gas wasn't an option because the long cooking time made it too expensive. Most all traditional foods and food prepared for festivals are cooked over fires. This means

that trees for firewood are still an important use even though gas is available. Many respondents said that they used to use native trees more for firewood and that they actually prefer the native hardwoods but now it is impractical to use native trees because the forests are so far away. One respondent said:

> *I used to use native trees for firewood but now the forests are so far away and I have trees like aliso and eucalyptus much closer* (1205).

The graph below shows the most common firewood species today:

Figure 4. Preferred Firewood Species



Many households said that fruit trees were the most important trees because they provide a needed food source and can be sold when they have a surplus. One respondent said,

> *I have fruit trees because they are good for my children and family. When I have a lot I sell them and with the money I can buy things the family needs* (1101).

Eucalyptus was by far listed as the most important tree in regards to its productive functions. This attitude is best summed up by one key informant:

> *Eucalyptus is the most important tree here because it can be used for wood, construction material, boards, and firewood* (1303).

Although eucalyptus is the most important tree for productive uses today, it was not always. Before the large scale conversion of forest to pasture, native species were preferred. One respondent captured this attitude best,

> *Before native forest trees were more important, but now the most important tree is eucalyptus* (1204).

The fact that eucalyptus was listed as the most important tree by most respondents needs to be reconciled with the fact that 82% of respondents listed eucalyptus as being a tree that dries the land. The tradeoffs between the benefits and problems of eucalyptus are best summed up in the words of one respondent:

> *There are advantages and disadvantages involved with eucalyptus. The advantage is that this tree has many uses – firewood, construction material, etc. On the other hand, the disadvantage is that it dries the soil and that is bad for our crops.* (1111)

Many respondents acknowledged that eucalyptus dries the land but they plant it because of its many uses. This is seen when one respondent compares pine and eucalyptus, "Pine trees serve no purpose – they dry the soil and remove the soil nutrients. Eucalyptus does this too but eucalyptus has many uses" (1103). Most respondents said they solve this issue by planting eucalyptus in places that are far away from their crops as explained by one respondent,

> *We all have eucalyptus on our land but not near our crops because it dries the soil and that is no good for our corn. No, we plant our eucalyptus away from our crops – along the boundaries of our pasture or in places that serve no other purpose.* (2202)

b. Protective Functions

51% of respondents identified the importance of trees with some protective function they served. 11% of respondents said that trees purify the air, 9% said trees bring rain, 6% said trees prevent landslides, 6% said trees help maintain biodiversity and a healthy environment, 6% said trees serve as windbreaks, 4% said trees provide

shade, and 4% said trees help recuperate the soil. 26% respondents specifically listed aliso because of its many uses (fixing nitrogen, leaves make good fertilizer, maintains humidity, and for living fences). The benefits of aliso are summed up by one respondent,

> *Aliso is good for the soil because it give nitrogen to the pasture, the shade it makes helps to conserve the moisture content of the soil, and the leaves of aliso make good fertilizer* (2203).

6% respondents gave cultural or spiritual importance to trees. One respondent said that trees are "fundamental to society and that without trees there can be no life" (7104). 4% of respondents said that trees serve a spiritual function – "they absorb bad energy" (3105) and they are "a source of great power and energy" (1111).

With that general description of the types of systems, species found and their main uses, I will now turn to a more in-depth discussion of each land-unit type.

4. Residence Land-Unit

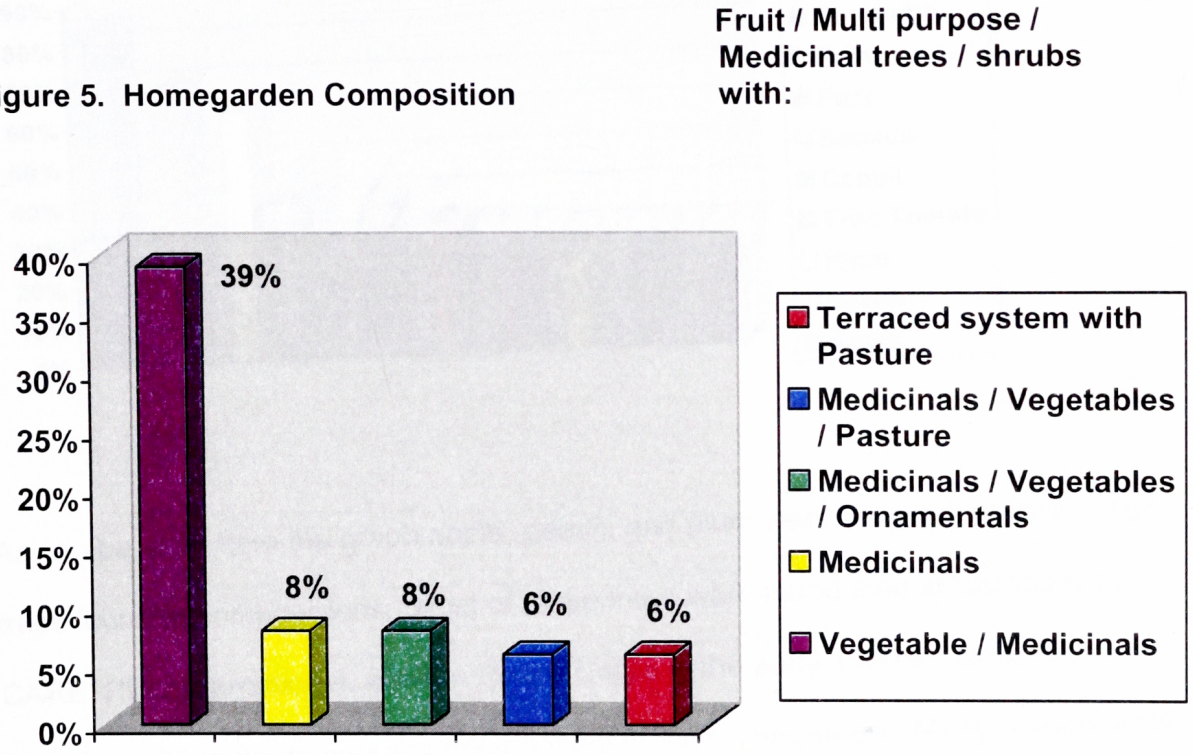
The residence land-unit always contained the house and was always located within a community's boundaries. Landowners arrange trees in the residence land-unit as hedge rows, as living fences, as wind break, as randomly spaced fruit trees, orchards, and homegardens.

a. Homegarden

Homegardens deserve special treatment here because they are the most complex and varied of all tree incorporating systems and are a key component in the livelihood strategy of the Saraguros. All 47 households reported having a homegarden. Homegardens include fruit / multipurpose trees and medicinal shrubs in combination with one or all of the following: vegetables, medicinal plants, ornamental plants, and

forage grasses. Trees are used in homegardens mainly for productive purposes of fruit and medicine, although trees were also used for shade and their nitrogen fixing capabilities. Trees in homegardens were used for firewood to a lesser extent. The graph below shows the most common homegarden types:

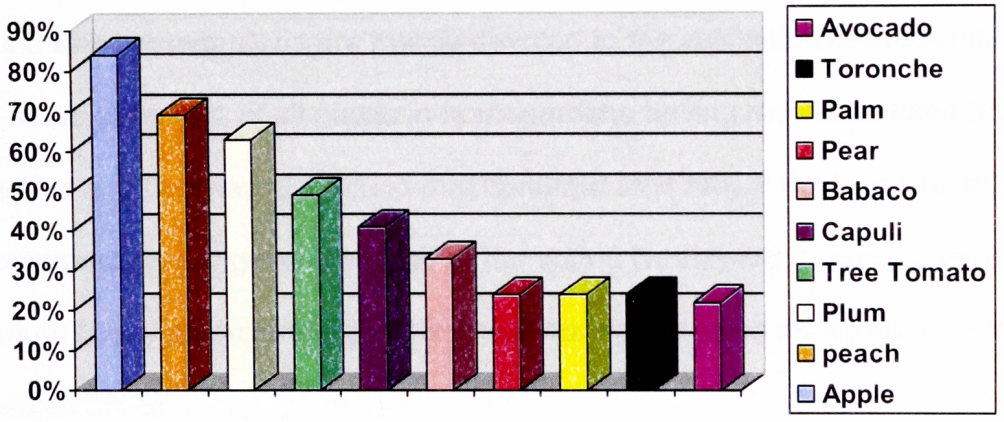
Figure 5. Homegarden Composition



Relying on interviews alone to uncover the contents of homegardens proved to be problematic. The complexity of these systems makes it difficult for respondents to list all of the species present. Also the homegarden is the domain of women (Finerman and Sackett 2003) and as such, male respondents were unable to give me detailed descriptions of the contents of the homegardens. The participatory mapping exercise better captures the nature of homegardens. The main medicinal shrubs present were: cedron (*Lippia citriodora*), floripondio (*Brugmansia spp*), malva (*Althaea rosea*), matico (*Piper angustifolium*), pena pena (*Fuchsia L. sp*), romero (*Rosmarinus officinalis*), and

sauco (*Cestrum auriculatum*). A number of multipurpose trees were also common in homegarden plots – aliso, guato / cañaro, agave, and willow. Fruit trees were listed most often in interviews as important components of the homegarden. The chart below gives the most common fruit species listed:

Figure 6. Fruit Trees Found in homegardens



As can be seen from the graph apple, peach, and plum were the most common fruit trees found in homegardens. Most of these trees were introduced in Saraguro by CARE, Plan International, and the Peace Corps in the early 1980's. Since then fruit trees have become an important component in the homegarden. Many respondents said that fruit trees were an important source of food for their families and that with fruit trees they did not have to buy fruit. As one respondent said, "Now that we have fruit trees we don't have to buy fruit" (7205). Another respondent said, "Fruit trees are the most important trees because they provide food and nutrients for my children" (1106). While some families keep fruit trees mainly for subsistence purposes, others sell fruit when there is a surplus, "Fruit trees are mainly for my family but in years when they produce a lot I can sell them at the local market" (5103). Others rely on fruit sales for part of their yearly income, "Fruit trees are necessary for my family.

Every year I produce apples and peaches to sell" (6204) and "Selling fruit is good business – it helps us buy things we need" (3107).

Every homegarden contained medicinal shrubs and plants. This is a key aspect of the Saraguro homegarden. Many households suggested that their homegardens provided for most of their medical needs. This finding echoes the findings of Ruthbeth Finerman and Ross Sackett (2003) in their study of homegardens in Saraguro. They found that homegardens are mainly devoted to the cultivation of medicinal plants with an average of 70% of all plants in homegardens having medicinal uses (Finerman and Sackett 2003). They also found that homegardens reflect the lifecycle of the family. Homegardens are generally small at the young family stage; growing larger during the mature family stage; and again declining during the aging family stage (Finerman and Sackett 2003).

Homegardens do not require much space and as such are not dependent on a household having large landholdings. Homegardens are always located close to the house, sometimes only a few yards away from the front door. A homegarden's composition is tailored to the individual household's needs and also reflects their choices on how to engage the market economy. Two homegardens that I mapped were larger than most the others and had a much larger section dedicated to medicinal plants. These two households contained individuals who where natural medicine healers and shaman respectively. These homegardens reflect the needs of the occupation of healers. A few households sold vegetables for the local market. The vegetables were incorporated into the homegarden system with more space being dedicated to vegetables compared with households who did not sell their vegetables. A few households had recently begun the commercial production of

guinea pigs and their homegardens reflect the need for forage grasses. In one system, over 90% of the understory was dedicated to forage grasses.

Homegardens are a complex fusion of both old and new species. Apple, peach, plum, and pear are all recent introductions. Starting in perhaps the 1980's but more systematically in the 1990's, CARE, PLAN International, and Peace Corps all had projects to introduce fruit trees. These organizations also introduced new vegetables such as broccoli, cauliflower, tomatoes, carrots, zucchini, and cucumber. These new components are grown along side older components such as pena-pena, floripondio, and sauco. The homegarden can be seen as a microcosm of the Saraguran situation. The Saraguros do not adapt wholesale the practices introduced from the outside, but rather pick and choose what to use and combine those elements into their existing systems.

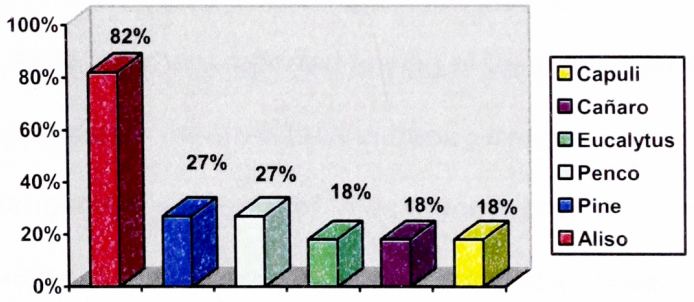
4. Field Agriculture Land-Units

Field agriculture land-units (*chacras*) are always found either within the community or directly outside of it. In Tuncarta (which is the lowest community), field agriculture was found as low as 2400 meters and in Illincho field agriculture was found as high as 2800 meters. In all cases, field agriculture does not occur above 2800 meters. Field agriculture usually consists of a corn, bean, squash polyculture rotated with peas. Corn is planted in October or November and harvested in June or July. After the corn harvest, peas are planted and harvested in October before the planting of corn begins anew.

Field agriculture land-units were found to have the least amount of trees or shrubs. While all households reported having field agriculture land-units, only 23% reported having trees on these parcels. Most respondents said this is because trees compete

with the corn for light, space, and nutrients. "Trees produce shade and that is bad for my corn" (1205) and "Trees occupy too much land and they take all the nutrients out of the soil" (8304). When trees / shrubs were present they took the form of hedge rows (73%) or living fences (27%). Trees were used mainly for their ability to improve the soil quality through fixing nitrogen, leave litter, and shade to help maintain moisture content. Trees also provided a source of firewood that was close to the home. The chart below list the most common species reported in field agriculture land-units:

Figure 7. Tree Species Found in Field Agriculture Land-Units



Nine out of the eleven households reporting trees on their field agriculture land-units also reported having worked with CARE to plant those trees. And the other two households reported getting the trees from CARE. This finding suggests that using trees combined with field agriculture was a CARE initiated system. This is also reflected in the main species used. Aliso, pine, and eucalyptus were all introduced by CARE and other organizations. Given the negative comments about pine and eucalyptus drying the soil, I was surprised to see so many of these trees present. These high percents are partly explained by the nature of the classification system. In some cases, a field agriculture land-unit has sections that cannot be used for crops and therefore trees are located in these sections and not directly next to the crops. In

one land-unit I mapped, pine trees were inter-planted with alisos right next to the cornfield. The landowner explained that the alisos help to mitigate the negative affects of the pine (6201).

6. Pasture Land-Units

Pasture land-units are usually located further away from the communities (between a half-hour and 3 hour walk) and higher in elevation. Most pasture land-units occur on land that was forested. Since the 1940's when new markets were opened because of the completion of the Pan American Highway, most Saraguros have pursued commercial cattle raising as a key component in their livelihood strategy. All cattle are individually staked to the ground so fencing is not an issue.

All landowners reported having at least a few trees on their pasture land. Respondents reported having trees arranged in five basic ways. The most common arrangement was rows of trees to mark one, some, or all of the boundaries. Landowners classified these as: hedge rows (*linderos*), living fences (*cercas vivas*), or wind breaks (*cortinas rompevientos*). Respondents would usually say specifically what the purpose of the row was for – "I have a living fence around my pasture to keep other animals out" (8201) or "I have a hedge row with only a few trees to mark the boundaries of my property" (2203) or "The wind is very strong so I have a windbreak on the two sides of my pasture where the wind usually comes from" (4201). 70% said they had trees in hedge rows, while 17% and 9% said they had trees in living fences and wind breaks respectively.

Trees were also arranged in lines to divide the pasture into separate sections. Dividers were used by landowners who were renting out their pasture. Dividers made it easier for them to rent out sections of their pasture to different households. One

household had trees arranged along the contour line of their pasture every 50 meters. This was a system designed by CARE to help prevent soil erosion.

Some landowners had fruit trees randomly spaced within the pasture. Fruit trees were only found in pastures that were close to the communities and below 2700 meters. These trees were used mainly for household consumption.

Trees were also arranged on pasture land-units in clusters. These are multipurpose wood lots or native forest / shrub. In this scheme trees are either planted in sections of the land-unit that cannot produce pasture or native vegetation is kept for the same reason. The planted trees mainly were eucalyptus, aliso, or pine. These trees were used for firewood and construction material. In the case of forests and shrub land, they are usually on the slope above the pasture for protective purposes. One landowner explained why he keeps trees on the slopes above his pasture:

> *Trees are important because their roots help to recuperate the soil. Trees strengthen the land. Trees give energy back to the land – they are the life of the land. With lots of roots trees help to protect the soil against landslides* (1102)

The first graph below shows the frequency of these tree arrangements and the second graph shows the most common species found on pasture land-units:

Figure 8. How Trees are Arranged in Pasture Land-Units

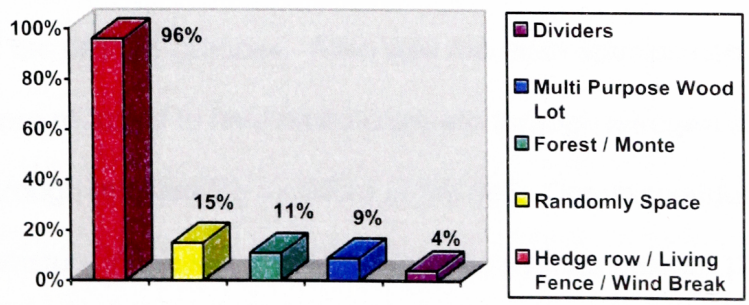
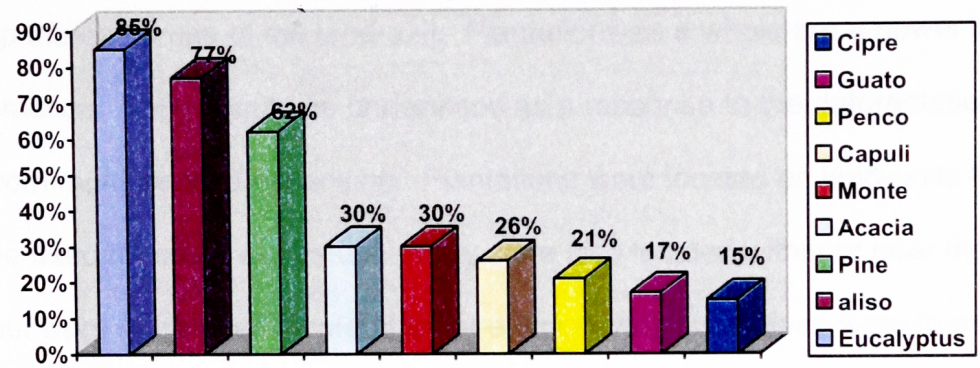


Figure 9. Tree Species Found in Pasture Land-Units



Households reported having trees in pasture land-units mainly for firewood and construction material security and self-sufficiency. Many stated the fact that forests were far away and they needed wood closer to their homes. One respondent said,

> *The forests are too far to get wood from on a daily basis, but we still need wood for cooking and for our houses – so we plant trees in places we cannot use for pasture* (3102).

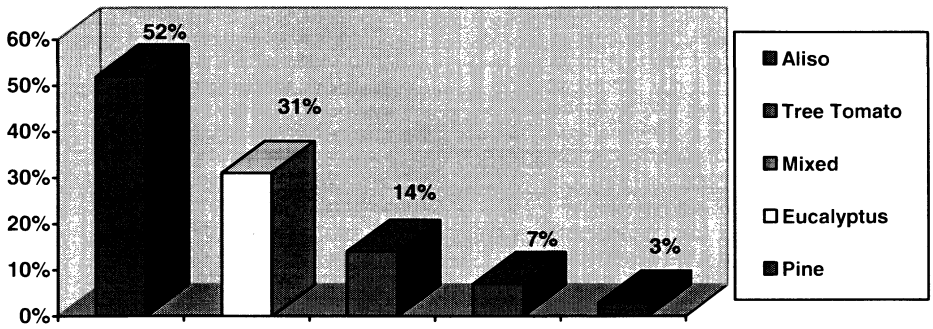
The site characteristics of pasture land-unit played a role in determining how trees were arranged and what species were used. Where all land could be used for pasture, trees were confined to the property boundaries. But on land units that that had sections too steep or too degraded for pasture, households had trees arranged in clusters on these sections.

Households also reported having trees on pasture land-units to improve the quality of the pasture grasses. Aliso was the main species used for this purpose. Alisos were reported to help pasture growth through nitrogen fixing, leaf litter as fertilizer, and through maintaining moisture in the soil. One respondent said, "Alisos conserve the moisture in the soil and that improves pasture growth" (1105).

7. Plantation land-units

Plantation land-units are the first land-unit type to be discussed where trees make up the entire use of the land-unit. Plantations as a whole are a newer land-use practice. They should be understood as a response to the deforestation that resulted from rapid pasture expansion. Plantations were located on land-units that could not be used for crops or pasture. They were also located within or near the community but were more often located further away. Many plantations were found on steep land that was previously covered with native shrub-land. These plantations cover both community owned and private land. CARE, the Ecuadorian Ministry of Agriculture and Livestock (MAG), and the Ecuadorian Program for the Development of the South (PREDESUR) all initiated plantation programs beginning in the early 1980's. More than 800 hectares was planted with pine by CARE alone (Carlson and Vieira 1992). The table below gives the main types of plantations found in Saraguro:

Figure 10. Plantation Types



62% of landowners have plantations. 80% of these households worked with CARE in establishing their plantations. The 20% who did not work with CARE still obtained the trees from CARE. Pine plantations received the most negative comments. Many respondents did not think that pine trees served a purpose. One respondent said,

"There are many problems with pine plantations – they do not serve a purpose. Pine trees dry the soil and take out all the nutrients" (1103). Another respondent said,

> *CARE put the pine plantations way up high far away from the community because you have to plant them far away from crops and pasture. But because they are far away they serve no purpose – they are too far to get firewood from on a daily basis* (1204).

Respondents indicated that plantations were mainly for construction material, firewood security, and also for sale. The eucalyptus plantations were listed mainly for construction material. A few households with big eucalyptus plantations sold the wood locally. Pine plantations were used mainly for firewood although many households reported that their pine trees were not big enough yet to use them for lumber. Most households believed that pine was bad for house construction but that the wood was good for furniture. One respondent said, "Pine is a great wood for making tables and chairs but isn't good for house construction because it is too soft" (1108). A number of respondents said that they planted pine plantations because CARE said they could sell the wood when the trees were big enough. These respondents lamented the fact that they could find no market for pine, "I want to sell my pine trees but there is no market" (6201).

8. Native Forest / Shrub land-units

45% of respondents indicated they had land-units covered entirely in native forest or in shrub land. Forested land is usually found in the upper reaches of the basin close to the Continental Divide. Some of the most common reasons given for not converting this land to other uses were it is too far from residence, too high, or too steep. One respondent said, "My forest is too high and too far away to be used for anything" (3103). But there are indications that households maintain forested land for conservation and ecosystem service purposes. Pelah Hoyt in her study on Saraguro

cloud forest conservation found that only 21% of households conserving their forests were conserving because it was too high or too steep. 79% of conserving households were conserving for other reasons. Hoyt found these households were conserving for a combination of reasons including for the ecosystem services they provide, for future option values, for forest products, and for cultural and well being reasons (Hoyt unfinished manuscript).

Unlike all the other land-unit types, a considerable difference was found between the communities in regards to native forest ownership. The communities closer to the continental divide had more forests than those further away. Illincho, Lagunas, Gunudel, and Ñamarin all had around 50% of respondents who owned forested land. In contrast, Tuncarta had 10% of respondents with forested lands while Yucucapa had 0% and Quisquinchir had 20%. This difference reflects the fact that these communities are lower in elevation and dryer than the others. The forests were probably removed from this area a lot earlier than higher up the basin. The remaining forested lands should be viewed as remnants.

Shrub-land was found mainly on land that was too steep or degraded for other uses and also was found more often in the dryer zones. Shrub land is often a source of firewood especially for the less well off and for those from the dryer communities. A number of the poorer respondents from Yucucapa and Quisquinchir reported getting most of their firewood from shrub-land. One respondent said,

> *I get most of my firewood from the shrub land. We cannot afford cooking gas so without the shrub-land we would be in trouble because we do not have enough trees on our land for all our firewood needs.* (7205).

9. Greenhouses

15% of households reported having greenhouses. These are included in this study because most grow the fruit tree babaco (star fruit). 75% said they have pure stands of babaco in their greenhouses and 25% reported having stands of babaco with vegetables growing in the understory. Tree tomatoes will also be included here because they are a longed live woody species that function structurally as a tree. Tree tomatoes are not grown in greenhouses but are planted in closely spaced orchards. Tree tomato and Babaco are grown mainly for commercial purposes. While other fruit grown in Saraguro is for sale locally, tree tomato and babaco is grown for the national market. They can be seen as a response to new market opportunities. One respondent said,

> *I have a greenhouse because it is easy, close to the house, and is a good business to sell them in Loja and Cuenca.* (1113).

The first greenhouses in the Saraguro basin were constructed in 1995. An informant who had a hand in bringing greenhouses to Saraguro explains the process:

> *In 1995 I went to a course on greenhouses in Ambato. The course taught how to grow babaco and tomatoes in greenhouses. So I came back from this course and asked the boss of CARE in Saraguro to help me to start a greenhouse. So we started one with a group from San Lucas. This was the first greenhouse in all of Saraguro – this was in 1995.* (2308)

Today there are many more greenhouses and tree tomato plantations in the Saraguro basin. I did a count of all the greenhouses and tree tomato plantations within the eight communities of the study area. The results are listed below:

Figure 11. Greenhouse / Tree Tomato Index

Community	Greenhouse	Tree Tomato	Pop (est.)	# HH (est.)	% G.H	% T.T
Illincho	06	05	750	150	4%	3%
Lagunas	15	05	800	160	9%	3%
Gunudel	10	00	900	180	6%	0%
Ñamarin	09	08	700	140	6%	6%
Tuncarta	06	01	1250	250	2%	0.4%
Yucucapa	02	02	265	53	4%	4%
Quisquinchir	11	12	650	130	8%	9%
Total	**59**	**33**	**5315**	**1063**	**6%**	**3%**

*Population / Household estimates from Municipio de Saraguro 2001.

The percentages here show that my respondents over represent greenhouse owners. Yet taken together greenhouse babaco and tree tomato production represent 9% of households in the study area. A few respondents lamented that many people sell these fruits now and the price is not as good. One respondent said,

> *I started my greenhouse because I could make good money. But now many people have greenhouses and it costs me more to maintain my greenhouse than I can make from it.* (3102)

Greenhouse production of babaco and open air tree tomato plantations are two ways some households have chosen to engage the market economy. It was shown above that other households have chosen to pursue different income generating markets. Some have pursued apple, peach, and plum production for the local market, others grow vegetables for the same purpose, still other raise guinea pigs. These examples show that how a household chooses to pursue a livelihood strategy influences the types and patterns of trees on their farms. So far the main focus of the analysis has been on the level of the land-unit. The types of tree incorporating land-use systems found in Saraguro were fairly uniform throughout, although how those components were arranged on any particular parcel of land was highly individual. This needs to be understood through the lens of livelihood strategies and the larger context within which they operate. It was shown in the context section that the Saraguros

pursue a livelihood strategy based mainly on homegardens, field agriculture and cattle production. The entire land based resource of a household then will be geared toward the production of these items. Therefore, tree-use will conform to these land-use practices. This is why the tree incorporating land-use systems were found to be fairly uniform. They are similar within the broad constraints of the homegarden, corn, and cattle livelihood strategy.

The next part of the findings section begins to integrate the all the findings at the land-unit level into the overall livelihood strategy pursued by individual households. Every household uses these various land-units to create a livelihood strategy that encompasses all of the subsistence and commercial activities and needs of that household. By understanding how all of the parts fit into the entire resource base of the household, I begin to uncover patterns in tree use.

B. Livelihood Strategies

It has been shown in the preceding sections that the Saraguro's livelihood strategy revolves around the homegarden, field agriculture, and cattle raising. It has also been shown that within this strategy there is considerable variation. All households pursue a strategy based on subsistence and commercial activities. Since the 1940's cattle production has been the main commercial activity of the Saraguros. But since at least the 1970's there has been further diversification in on-farm commercial pursuits. Each household chooses to pursue the market economy to differing degrees and as such the livelihood strategies needs to be viewed as a continuum. There are actually two continuums at work – one of high to low subsistence activities and one of high to low commercial activities. Two scales are needed because high commercial activities does not necessarily mean low subsistence ones and vice versa. Most households

fall somewhere in the middle reaches on both of the continuums. How a household chooses to pursue a livelihood strategy will influence how and why they use trees on their land. This section explores the livelihood strategies of the Saraguros and their implications for tree use.

Livelihood strategies will be explored at different levels of scale. On the larger scale, livelihood strategies will be placed within the larger social-ecological-historical context. On the smaller scale, the factors that influence livelihoods will be explored in relation to how they affect household tree-use. Earlier it was said that tree incorporating systems were similar within broad constraints but highly individual in how the components were arranged. This needs to be understood through the lens of livelihood strategies and the larger context within which they operate. To a large extent the similarities are explained by the broad constraints of the larger context within which livelihood strategies operate. And the differences are largely explained by the smaller scale factors that influence the decisions households make concerning their livelihood strategies. In what follows, it will be shown that household land-units were highly individual because of various factors that influence how a household chooses to pursue its livelihood strategy. These include size and quality of landholdings, food/firewood/construction material security/self-sufficiency, and individual choices on how to engage the market economy (including off-farm employment).

It was shown in the context and findings sections that the Saraguros pursue a livelihood strategy based mainly on homegardens, corn and cattle. The entire land resource of a household then will be geared toward the production of these items. Therefore, tree-use will conform to this three part strategy. This is why the tree incorporating land-use systems were found to be fairly uniform. They are similar

within the broad constraints of the homegarden, corn, and cattle livelihood strategy. These broad constraints can be understood within the larger context of space, time, and scale. The types of livelihood strategies that can be pursued in the first place are dependent on the ecology of the place. The elevation, precipitation, daily and annual temperature fluctuations, soils, and topography will all help to determine what can be produced in the first place. Only certain fruits and vegetables can be grown in Saraguro. The corn agroecological zone between 2400-2800 meters is where most of the crop production occurs. The higher cattle agroecological zone between 2800-3000 meters is where cattle raising and potato production dominate. In the historical section, it was shown that the corn culture of the Saraguros developed out of the Incan occupation of the basin and that the Saraguros incorporated cattle, sheep, horses, goats, and pigs into their livelihood strategy as a result of the Spanish occupation. These historical occupations have directly influenced the livelihood strategies and land-use practices of the present day residence of the basin.

The issue of scale is also important in understanding present day patterns and practices. In looking at the national and international scales, there are some important influences that help to explain land-use change. The completion of the Pan American Highway through Saraguro by the National government is critical to understanding land-use change in the basin. The road led to new markets which the Saraguros exploited in the form of cattle raising. This new market led to rapid deforestation through conversion of forested lands to pasture. In this sense, the Pan American Highway is to a large extent responsible for the cattle raising aspect of the Saraguro's livelihood strategy.

Yet, within these broad constraints there is considerable variability. As was shown, individual land-units were found to be quite different in terms of how components were

arranged on any one land-unit. In what follows, it will be shown that household land-units were highly individual because of various factors that influence how a household chooses to pursue its livelihood strategy. These include size of landholdings, key site characteristics, food/firewood/construction material security/self-sufficiency, and individual household choices on how to engage the market economy (including off-farm employment).

1. Size of Landholdings

The size of a household's land base influences livelihood strategies. Each household must work within the constraints imposed by its finite resource base. Landholdings were shown to be the result of inheritance patterns and risk management strategies (Belote 1984). The landholdings I mapped ranged from half a hectare to 15 hectares with three to six hectares as the average. A number of households illustrate how land size alone does not determine if a household will plant trees. One household I mapped had around a half a hectare distributed between the residence and a pasture land-unit. The household had small numbers of cows and sheep and had a homegarden although it was very small and was just being started. This household did not grow corn but relied on family members to supply her needs. The other land-unit was pasture. There were a large number of trees being grown on this land-unit in wood lots. Much of the land planted with trees could have been used as pasture. When asked why she was not using that space for more pasture she replied,

> *We are poor and cannot afford more sheep or cows so this pasture is sufficient for them. We need the trees because they provide firewood and construction material. Without the firewood supply we could not cook because we cannot always afford cooking gas. These trees are more important to us than pasture*. (6204).

Another household with small landholdings only has trees in their homegarden and on a section within their pasture land-unit that is too steep for pasture. This household indicated that they need all their land for production and cannot afford to plant trees because, "Trees take up too much space" (5101). They have a small stand of eucalyptus on steep land for firewood and construction material. "We get all our firewood and construction material from our own land – eucalyptus grow fast after you cut them" (5101).

These households can be compared with a household on the other end of the land size spectrum. One household was in the high wealth ranking category and owned 10 land-units totally around 14 hectares. Four of the land-units were dedicated to solely to pine plantations. This household also had large numbers of trees growing on their other land-units mainly in the form of hedgerows and living fences. The landowner reported having the pine plantations mainly for commercial purposes and the trees in hedge rows mainly for subsistence use (6201).

Another household with large land holdings only had trees in their homegarden, on the borders of their residence land-unit, and had some native shrub land on a section of their pasture land-unit too degraded for pasture production. This household had a small percentage of trees relative to the size of their landholdings. They did not have any animals and both heads of household had full time off-farm employment. So in this case it was obvious that other factors came into play to influence tree-use decisions.

Households with average sized landholdings also run the spectrum of having only small percentages of trees to having high percentages of trees. Yet regardless of size, every household had at least some trees. Most households got all of their

firewood and construction material from trees on their land and all households had at least a few fruit trees.

These examples show how size of landholdings influence why households have trees but not necessarily if they have them. In this example both rich and poor households were found to have large numbers of trees relative to their landholdings. So land size cannot be an indication if a household will plant trees or not. But the purpose the trees served were to some extent determined by land size. The main purpose for trees in the poorer household was for firewood security while in the wealthier household, firewood security was not so much an issue as having trees for commercial production.

2. Key Site Characteristics

Related to size of landholdings is quality of landholdings. Quality is determined by such things as degree of slope, soil quality, and location. All flat or moderately sloping land is used for either crop or pasture. Steep and severely degraded land is covered either with planted trees (pine, eucalyptus, aliso) or is covered with native shrub vegetation. The general trend in tree use is best summed up by one informant:

> *People use their land mainly for agriculture and cattle. So they have most of their trees in places that they cannot use for agriculture or cattle raising – like steep places or undesirable places.* (2308)

From this statement illustrates that tree patterns are often closely related to quality of land – the poorer quality land almost always containing trees. Every household either had planted trees or native trees / shrubs on land that was of too poor quality to be used for either agriculture or pasture. While this explains to a large extent where trees will be found on the land, other issues of land quality help to explain what types of trees are found.

The many microclimates found within the Saraguro basin made location important. Amount of precipitation and elevation are key to location. The community of Tuncarta is hotter, dryer, and lower than all other communities included in my study. This has led landowners to use aliso to help regulate the microclimate at the field level. Landowners wanted more shade and more moisture content in the soil. All households surveyed in Tuncarta said alisos were important for the protective functions they served. One landowner told me,

> *It is very dry here in Tuncarta, therefore we need more irrigation than other communities – also alisos are more important here because they help to maintain the moisture content in the soil* (5204).

In the communities of Illincho, Lagunas, and Gunudel, too much moisture in the soil is often a problem particularly on flat or slightly sloped land without good drainage. Often soils are completely waterlogged, especially during rainy months. Households in these communities often plant trees that are known to use a lot of water such as eucalyptus or willow. When asked why he planted eucalyptus above his pasture, one landowner told me,

> *To prevent erosion. Eucalyptus dries the soil and that is good for the soil here because sometimes it gets very wet and when the soil in very wet it can cause landslides* (8201).

Another landowner planted a hedge row of willow to help dry nearly flat pasture land. "This pasture is wet all the time so I planted this row of willows to help dry out the wettest sections of my pasture" (8202). When asked why he used willow instead of eucalyptus he said:

> *Willows grow fast and produce a lot of branches that I use for firewood. I like willow because it doesn't die when you cut off a lot of branches. When the leaves of willow fall they make fertilizer and help my pasture grow, but nothing grows under eucalyptus. The leaves of eucalyptus do not make good fertilizer – they fall but they do not decompose* (8202).

So while households will plant trees known to use a lot of water on waterlogged land, what specific species that will plant is up to the individual choices of the household.

The soil quality on land in production is another important influence on tree use. Where soil quality is bad, many households have planted nitrogen fixing trees to help improve crop and/or pasture growth. One respondent said, "I have aliso and guato to improve the soil in my pasture" (2203). Another respondent echoes that statement,

> *Aliso is beneficial to the soil – its leaves help to fertilize the soil and its roots add nitrogen to the soil – with aliso I don't have to buy as much fertilizer.* (3102)

Elevation also affects tree-use. Above 2800 meters there are no fruit trees and fewer eucalyptus trees. In the upper reaches of the basin are found the remnant forests. These forests remain partly because it is too high and too steep for other uses. A common response of households that owned land in the upper reaches of the basin was, "We are going to let the forest remain up there. It is far away and too high and steep to do anything with it" (1106).

These examples illustrate how key site characteristics will affect where trees are planted and what species of trees households will plant. On land that cannot be used for corn or cattle, households will plant trees. But on productive land, households plant trees to conform to the land-use type and choose species based in part on the quality of the land. Quality of land perhaps more than all other factors determines the patterns and species of tree use on the household level.

3. Food Security / Self-Sufficiency

Food security and self-sufficiency was found to be an important part of the Saraguros overall livelihood strategy. The level of household food self-sufficiency varied widely. On the low end, families produce around 20% of their food for an entire

year. On the other end, some households produce around 80% of their food in a year. Increased integration into the market economy has made households less dependent on corn yields. Rice has complemented corn on a day to day basis in many households. This is not to say that corn has lost its value culturally, but just that household wellbeing is not as directly dependent on corn yields. Because of increased integration into the market economy, more households are supplementing their subsistence foods with purchased foods. But households are also diversifying their subsistence agricultural base as well. In many households, homegardens contribute more to food production then they had in the past. The vegetable garden projects initiated by CARE and PLAN have helped to increase vegetable yields by introducing new vegetables like cauliflower, broccoli, carrots, cucumbers, and tomatoes. Most of these vegetable were integrated into the homegarden and as such make up the understory of an agroforestry system that includes fruit, medicinal, and multi-purpose trees and shrubs.

Fruit trees were also introduced by CARE and PLAN and now form an important part of a household's livelihood strategy. Every household surveyed had at least a few fruit trees. 36% of respondents listed fruit production as the primary importance of trees on their land. A common response to the question of the most important tree on their land was, "Fruit trees because they provide food and nutrients to my family" (5103). Most respondents indicated that they like to grow their own supply of fruit and not have to pay the high prices for fruit in the market. As one respondent said, "I have fruit trees so I don't have to buy fruit at the market and fruit helps to nourish my children" (3102). Overall, fruit trees were seen as an important aspect of food security and some space close to the home was always dedicated to fruit tree production. The nutritional element was singled out as being important especially for children.

Food self-sufficiency is directly related to amount of land dedicated to field agriculture. The more corn households grow, the more self-sufficient they are in terms of food. The amount of land a household has in field agriculture will influence tree use. Only 23% of households had trees in field agriculture land-units. So most households will not have trees on field agricultural land-units. But this does not mean that the more food self-sufficient a household is the less trees they will have. It only means that they are less likely to have trees on agricultural land-units but may have trees on other parts of their farm.

The few households that did have trees on field agriculture land-units said that trees contribute to better crop production. Within these households, trees on field agriculture land-units contribute to food security by increasing yields. On respondent said,

> *Aliso are great for windbreaks and they help my crops against the wind. Their leaves make good fertilizer and they conserve the moisture in the soil. So I think that aliso helps to improve my crops.* (1105)

For all households, food security and self-sufficiency are important aspects of their livelihood strategy. Fruit trees play an important role in food self-sufficiency. It was shown that every household had at least a few fruit trees and that fruit trees helped to lessen dependence on market bought foods. Households varied on the percent of food self-sufficiency they maintain but all households still produce some of there food and most households strove to be relatively self-sufficient in terms of their food supply. This can be seen not only with fruit trees but through the diversification of agricultural products for household consumption. Households now grow many more types of vegetables in homegardens than they did in the past. These systems rely on an overstory of trees to provide shade and other inputs. Land dedicated to field agriculture was found to have low percentages of trees but on units that did have

trees, the trees protective functions were used to help improve crop yields and therefore increase food security.

4. Firewood and Construction Material Security

Firewood and construction material security and self-sufficiency was also found to be an important component of the Saraguro's livelihood strategy. As stated above, 51% and 49% respectively listed firewood and construction material as one of the primary importance of trees on their land. All respondents said they used firewood for cooking at least some of their food. Most respondents also indicated that they rely on trees from their own land for construction material.

Increased tree production on a household's land needs to been seen as a response to the decreasing supply of native forests. As more and more forested land was converted into pasture, households began to spend more time collecting firewood and obtaining wood for construction. The situation reached its worse point in the 1970's. One respondent remembers,

> *About 20 years ago it was like a desert here – there were no trees and no firewood. But now there are lots of pine, eucalyptus, and aliso trees that are close to the communities. So now we have firewood and construction material.* (1105)

Most landowners have responded to this decrease in forest trees by planting more trees on their land. These trees are planted mainly to ensure a secure firewood and construction material supply. This is best summed up by one respondent, "We have planted a lot of trees on our land so we would have enough trees for firewood and construction material" (1105). Another respondent indicated that having trees close to his house was an important aspect of tree-use. "I have trees on my land because it means more firewood and wood close to my house" (1110).

Households would rather grow their own trees than have to buy firewood or wood for house construction. Almost every household indicated that firewood and construction material security and self-sufficiency was an important part of their livelihood strategy. This feeling is summed up by one respondent, "We have trees on our land for wood and firewood so we don't have to buy them" (7101). This desire for firewood and construction material security / self-sufficiency is also seen in the main tree species present. The preferred firewood species were eucalyptus (70%), pine, and aliso (both 30%). Eucalyptus was by far the most preferred tree for construction material. Aliso and pine were the main trees found on agricultural land-units. Eucalyptus, aliso, and pine were by far the main trees found on pasture land-units and pine and eucalyptus were the most common plantation types. These species reflect the fact that households have trees mainly for firewood and construction material security / self-sufficiency.

5. Off-Farm Employment

51% of the households surveyed had some type of off-farm employment yet most had similar systems to those without off-farm employment. Since the 1980's and 1990's, there has been an increase in occupational diversification in Saraguro. There are many different types of off-farm employment – ranging from local part or full time to seasonal migratory work, to full time non local jobs. The type of off-farm employment will determine much of a household's livelihood strategy. Most of the households I interviewed had local off-farm employment. 32% of respondents with off-farm employment were teachers, 21% were professionals, 18% worked for a foundation, and 14% worked for the local government. With only local off-farm

employment represented I can say nothing about other non local off-farm employment affects on livelihood strategies.

Increased participation in the cash economy generally lessens a household's dependence on food and firewood self-sufficiency. Off-farm employment reduces the amount of time one is able to dedicate to crop or animal production. Having off-farm income does not determine if a household will have trees or not but rather how they will use the trees on their land. One household surveyed had both parents working full time jobs in the town center. They had a large homegarden with vegetables and medicinal plants and shrubs combined with fruit trees. They had a small cornfield and a pasture they did not use – except to grow trees on a large section of it. In regards to the trees, the landowner said,

> *We both work and we don't have cows so I planted a lot of trees here because all you have to do is plant them and let them be – and in the future I can sell some of them.* (7203)

Another household that had both heads of household working were growing babaco in a greenhouse. The respondent indicated that they were able to buy the materials needed for the greenhouse because of the money generated from off-farm employment. Another respondent worked as a mechanic and his wife grew vegetables for local sale. They had fruit trees and medicinal shrubs in their homegarden and only a few trees in their pasture land-unit. They did own a small land-unit high in the basin covered in native forests but they were not utilizing it because of the distance. This household did not have firewood self-sufficiency but rather got their firewood from their parents land. The female respondent said, "We don't have enough time to plant more trees and even if we had time we don't have enough space for many trees" (3106).

Less time for farm work could mean households plant more trees because trees are relatively low maintenance or it could mean planting fewer trees because the household does not have time to engage in another activity and can purchase alternatives to wood products. There are other factors that are also influencing tree-use. Off-farm income may allow households to dedicate more land to plantations because they have less cattle or the increased money available may allow some households to pursue commercial fruit production. Other households may not have many trees because of labor or space shortages. Off-farm income is just one of the factors influencing tree use decisions. Over half of the households interviewed had off-farm employment yet most had similar tree-use patterns and practices to those with no off-farm employment. So while off-farm income plays a role in tree-use decisions, it alone cannot be used to determine if or how a household uses trees.

6. Household Choices on how to Engage the Market Economy

Households choose to engage in the market economy in a number of different ways. In Saraguro, some of the most common ways are through the production of cattle, vegetables, fruit, medicinal / ornamental plants, wool products, and small animals. The particular engagement strategy strongly influences how that household uses farm trees. Fruit tree production has obvious implications for farm tree use. Relatively large chunks of land need to be dedicated to trees. This is usually on the residence land-unit or on a parcel close to the house. In most cases land was taken out of some other production system (field agriculture or pasture) in order to be used for fruit tree production. In some cases, the homegarden was expanded to include a larger area with 8 or more fruit trees combined with an understory of vegetables, medicinal / ornamental plants, or pasture. They also took the form of orchards where

all undergrowth was eliminated. CARE introduced a terraced system where fruit trees were combined with an understory of vegetables or pasture. A recent strategy has been greenhouse fruit tree production. This began as a response to increased demand for babaco (star fruit) for national markets.

A number of Saraguros have specialized in wool clothing production to sell to other community members and to the increasing flow of tourists. Many native and some non native shrubs and trees are used to dye the wool. One respondent told me,

> *In the past it was easier to get these plants to use for dyes. There used to be a lot of them close to the community. Now I have to walk two hours to find some of them* (4102).

She went on to tell me that she has a number of the shrubs planted in her homegarden and plans on transplanting more because it takes so much time to go to the hills to find trees and shrubs for dyes. This illustrates that her market engagement strategy influenced they types of trees and shrubs she had in her homegarden.

Small animal production for market engagement was another strategy some households were turning to. Guinea pig (*cuy*) is a traditional Andean fare that was becoming more commercialized. It was showing up more often on menus across Ecuador (per obs). There was even a growing market to export guinea pigs to the United States for the growing number of Andean migrants there (8202). In response to this growing demand, a number of Saraguros have begun large scale guinea pig production growing up to 200 guinea pigs. Large amounts of forage grasses are needed on a daily basis for these large scale productions. One of my respondents was building up a guinea pig stock of about 100. His approach to the need for large amounts of forage was to convert his vegetable garden into pasture production. In this new homegarden system, he has an overstory of fruit trees with an understory of knee to waist high pasture grass.

> *This system can provide food on a daily basis for a 100 guinea pigs all year long and it is jus eight meters from the cuy pens* (8202).

The landowners said the trees were a necessary component to the system because they provided shade and help to retain a cool humid environment in the understory that is crucial to good forage production (8202). In this system the fruit trees provide food and income for the family, the pasture feeds 100 guinea pigs, and the guinea pigs give back to the trees and grasses a steady supply of fertilizer.

Households must also adapt to changing conditions in the market economy. The unpredictable nature of regional, national, and international markets is a risk that is taken by those who choose to engage in it. Livelihood strategies are seen as stable if they can weather the normal ups and downs and cycles of market supply and demand. A livelihood is sustainable if it has the ability to get through a major shock in the market. Commercial cattle production suffered a major shock in 1999 when the national economy collapsed and Ecuador went to the dollar. This move increased the prices of all goods and services and created much hardship for the small landowner (Wunder 2001). In Saraguro, the dollar meant among other things that the price of cattle increased. This effectively closed the export market to Peru because Ecuador could no longer provide cheaper cattle. Not only that, but now Peru exports their cattle to Ecuador because they have cheaper prices. Since 1999, this has made cattle raising in Ecuador a lot less lucrative. This problem was made worse by the fact that many Saraguros had taken out loans to get started in cattle production. One informant explained it this way;

> *The price for cattle is very bad now with dollarization and there are a lot more cattle coming in from Peru. The problem with the price of cattle is it is always going up and down. For example, my father had 30 head of cattle but when the price went down [after dollarization] he had to sell most of this cattle to pay the bank back. I know other people who have had to sell their land to pay the bank back* (8304).

The factors listed above help to explain some of the influences that affect the household decision making process in relation to farm tree and agroforestry practices. Some of these links are stronger than others and the strengths of any one factor may vary from household to household. None of the influences act alone but are to be understood in relation to one other. The factors act together, each influencing the next and each playing out differently at different times and within different households. Within the broader constraints of the homegarden, corn, and cattle strategies there is space where the household accepts and rejects / uses and discards, based on the incentives and constraints present at any given time.

C. Institutions

1. Influence of NGOs

Two key findings lead directly into the role International NGOs played in land-use change. The first is that 70% of respondents reported having worked with an NGO and the second is that 40% of respondents said they learned about trees through NGOs. This is as many that said they learned about trees from their families (40%). This indicates that NGOs were influential and had an impact on people's knowledge of trees and tree-use. These findings prompted me to further investigate the role NGOs played in Saraguro.

49% of respondents reported having worked with CARE-Promusta and 13% reported working with Plan International. Other organizations that have worked in Saraguro include Peace Corps, Mission Andino, and a handful of local NGOs. CARE has had the largest impact in terms of reforestation, agroforestry, and fruit tree gardens so this study will mainly focus on CARE´s work in Saraguro

Respondents reported having worked with CARE in three main areas. Pine plantations (65% respondents), fruit tree gardens (57% respondents), and silvopastoral systems / pasture improvement (48% respondents). All reported that CARE gave them technical assistance in the form of classes, practical sessions, and on the ground design assistance. All respondents also reported that CARE either gave them trees for work done planting pine trees on communal land or sold trees to them for a low price. All respondents are still using the systems initiated with CARE's help.

Respondents gave a number of benefits gained from these systems. Wood for construction (65%) and firewood (57%) were the most common benefits reported. Other benefits include: fruit as food for household and for sale (35%), improved pasture production (13%), living fences (9%), and that trees are close to home (9%).

Many respondents thought that CARE's work was successful overall as one landowner said, "I am still using the trees I planted with CARE. I like the CARE projects – the projects were successful" (2106). A number of respondents said that they learned a lot about trees from CARE. One respondent said, "CARE taught us a lot about pine trees, fruit trees, and vegetables" (1103). CARE's success is best summed up by this respondent:

> *I learned about trees from CARE – in workshops and demonstrations. Before CARE came I didn't know much about trees and I cut down most of my trees to make pasture and for firewood. But I learned a lot from CARE. I planted trees with them and in three years I had a supply of firewood. I have had great success with the CARE projects. Now I have firewood – if CARE had not come I would not have trees now. They helped us a lot.* (6201)

While there were successes there were also a number of problems identified in relation to the CARE initiated projects. The main problem listed was that some species of trees CARE introduced dried the soil. One respondent said,

> *CARE told us that pine, eucalyptus, and acacia were good to plant next to our crops, houses, and pasture. But this was a lie – those trees dry the soil.* (1106)

A number of respondents lamented that the CARE initiated systems were not producing well. One older gentleman told of his son's silvopastoral system:

> *My son has a pasture with alisos inside it (this is a system CARE designed) but it is not good for the pasture. Below the alisos the pasture only grows a little – this is not a good system* (1204).

Others said that the systems did not serve a purpose.

> *CARE planted all these trees but the people here did not want pine trees – pine are bad for our crops and they do not serve a purpose – they are not good for construction material or firewood* (1204).

Some respondents even said that CARE gave bad or wrong advice. One informant told me,

> *CARE changed the trees here – they planted eucalyptus and pine but we did not want pine. CARE said that if you planted pine at least three meters apart then you could grow pasture under the trees. But CARE lied because nothing grows under pine* (1204)

Another respondent was more blunt, "CARE told us that pine, cipre, and acacia were good to plant with our crops and pasture, but it wasn't true" (7104). A number of respondents remarked that there were no markets for pine trees now that they are big and ready to harvest. One respondent with four large pine plantations told me,

> *I want to sell my pines now that they are big enough but there is no market for them in Saraguro* (6201).

13% of respondents reported having worked with Plan International. They all reported having worked with Plan on fruit tree gardens. All respondents received technical assistance and fruit trees for a small fee. All respondents said they still use their fruit tree gardens and all said the main benefits were food for their families and fruit as a cash crop. The main problems identified were that the fruit trees did not produce well and required a lot of maintenance.

2. Role of CARE

To gain a better understanding of CARE's role in land-use change. I did ten key informant interviews with local government officials who had worked with CARE and locals who had worked with CARE as community leaders and/or extension agents. I also analyzed a number of CARE internal documents (CARE 1990; CARE 1991; CARE 1994a; CARE 1994b; CARE 1996a; and CARE 1996b) and papers presented at two agroforestry conferences held in Ecuador (Carlson and Ronceros 1987; Carlson and Vieira 1992). . These findings are described below.

CARE began work in Saraguro in 1983 with Proyecto de Sistemas Forestales Comunales (Project of Community Forestry). The idea of this project was to take community owned shrub-land and plant plantations of pine (*Pinus patula*) and eucalyptus (*Eucalyptus globules*). CARE worked in 24 communities for 3 years on this project and planted 850 hectares of communal and private land with pine and eucalyptus (CARE 1991). In 1987 CARE reevaluated their work and came up with a more integrated plan that focused on soil conservation and agroforestry. This new project was a partnership between CARE and MAG (Ministerio de Agricultura y Ganaderia) and thus became CARE-PROMUSTA or Proyecto de Manejo y Uso Sostenible de las Tierras Andinas (Project for the Sustainable use and management of land in the Andes). This project continued until 1996 and is broken down into three phases – phase one: April 1988-April 1990, Phase two: June 1990--June 1993, and phase three: June 1993—June 1996. The project had five overall objectives. (1) Initiate projects in soil conservation and sustainable natural resource use, (2) Improve the living standard of project participants, (3) Educate participants in technical and general aspects of soil conservation and sustainable natural resource use, (4) set up

demonstration sites where practices can be observed by general public, and (5) extend the practices of demonstration site to participants land holdings (CARE 1994b).

The CARE-PROMUSTA partnership worked in 9 provinces in Ecuador with 160 communities and 9000 families (CARE 1996a and CARE 1996b). The general cycle for entering and working in a community is outlined by CARE (1996b):

Selection of the Community
- Preliminary selection
- Preliminary negotiations with the community
- Final selection

Diagnostic and planning phase
- External diagnostic
- Internal diagnostic by community members
- Participatory planning
- Contract with community

Training phase
- Practical training and participation
- Adoption and adaptation of natural resource management practices

Consolidation phase
- Practical training and participation
- Working toward project self-sustainability

Retirement phase
- Projects are self-sustaining
- Participants assume total responsibility for projects
- Extension workers participate less and less until leave community completely

CARE-PROMUSTA (1996a; 1996b) further outlines their specific strategies while working within a community:

- Direct participation from the community in the planning, execution, and evaluation of all activities
- Community training that emphasizes participation and observation
- Training community members to be group leaders
- Establishment of demonstration plots that highlight specific conservation practices
- Long-term strategy to give total control of projects to communities with the goal that they will become self-sustaining

I could find almost no data on how CARE came to Saraguro in the first place. I am not sure if they were invited or if they chose the region because of perceived environmental problems. I had one informant tell me that CARE came to Saraguro because they were invited by the Spanish Priests of Saraguro:

> *Around this time [late 1970's] people had to go to the mountains to get wood because there were no more forests left close to the communities. About this time two fathers [of the church] came to work in Saraguro. They saw the situations that Saraguro was in and they thought that Saraguro was rapidly becoming deforested. So they searched for an alternative. In about 1980, they wrote to CARE and this is how CARE came to Saraguro* (2308).

In Saraguro, CARE-PROMUSTA (1996b) initiated a number of activities that can be grouped into five distinct categories: (1) strengthen social organizations, (2) promotion and training, (3) sustainable agricultural practices, (4) sustainable management of pasture and livestock, and (5) reforestation and agroforestry practices. The first two categories will be discussed in detail because they highlight CARE-PROMUSTA's innovative approach to development and I believe they are responsible for the widespread diffusion of their "knowledge" and the overall success of their projects. It will be shown that CARE-PROMUSTA worked within the existing community structure, trained community members as extension workers, and invited community participation in all phases of the project.

CARE's willingness to work within the existing socio-political structures was seen first in their partnership with MAG (CARE 1996b). This showed cooperation on the national level with the Ministry of Agriculture and Livestock. They also had contracts with the Provincial government of Loja and the county (*Cantòn*) government of Saraguro (Carlson and Vieira 1992; CARE 1996a; CARE 1996b). On a community level, this willingness to work within existing structures was seen in their entering a community through the community government structure. This was reflected in the diagnostic and planning stage in the general cycle for working with a community

outlined above. Once CARE was invited to work with a community by the community governing body, they did an external diagnostic and helped the community do a diagnostic of their own. According to CARE documents (CARE 1996a,1996b) this led to participatory planning where both groups worked together to come up with a plan of action. Based on the outline of action, CARE and the Community Governing Council then drew up a formal contract that guided the interactions throughout the whole project cycle (CARE 1996a; CARE 1996b).

According to CARE documents other ways that CARE-PROMUSTA worked within existing social structures was through meetings and planning sessions with the community as a whole and various groups within the community. They worked through *mingas* (community governing council sponsored community work days), by training local group leaders, and by training and using locals as extension workers (CARE 1996a; CARE 1996b).

Using the *minga* structure to organize work days proved to be one of the strengths of CARE-PROMUSTA's work within the community and disseminated their "knowledge" more quickly and thoroughly than otherwise would have been possible. *Mingas* are called by the community government for any number of reasons relating to community interests (to work community land, clean irrigation canals, clean/fix community schools, and maintain trails). Participation in *mingas* is obligatory and fines are imposed on those who do not attend. Participation is usually based on the household where one or two members of a household have to attend. In the first projects initiated by CARE (1983-1987), they utilized *mingas* to plant pine and eucalyptus on community land. In the CARE-PROMUSTA phase, they utilized mingas to create demonstration plots. This was useful for two reasons – (1) there was a ready work force of at least one member of every family in the community and (2)

knowledge was disseminated quickly to every household in the community. Household members who participated in the minga then went back and shared the information with the rest of their family. Utilizing mingas proved to be the quickest and easiest way to disseminate CARE generated technical and general knowledge.

CARE trained Saraguros to be extension agents. They had between six and eight Saraguros working for them between 1984 and 1996. Each extension agent was responsible for 2 or 3 communities (Calson and Vieira 1992). They went to the community and did talks and initiated projects. The process is best described by one of the former extension agent:

> *The training CARE provided us [the extension workers] was excellent. The staff of CARE trained us and we taught the community members. Many people liked what we taught some didn't but all learned what we had to teach because of our classes and lectures during the mingas. In our talks we used slides. Oh, the people loved those pictures. This was a time when there wasn't much TV or videos. So we would go to a community and say 'come and look at our photos' and all the people would come. The presentation was very professional – an audio visual presentation that came from another country. Oh man, did the people love the slideshows. So this is how we worked.* (2308).

According to CARE-PROMUSTA documents (1996b) their promotion and training strategies helped to further demonstrate their involvement at community, group, and household levels. CARE-PROMUSTA initiated a number of activities to help ensure participation. First, they held small one-day classes dedicated to a specific theme (CARE 1996b). This allowed people with a particular interest to learn about that subject matter in a way that did not require a large time commitment. Second, CARE-PROMUSTA held multi-day workshops. In the words of CARE (1996b) these are "events of participatory training with the objective of covering diverse themes where at the end of the workshop, community members give their conclusions and recommendations so as to help improve the quality of the activity" (CARE 1996b).

Field trips were organized to farms that served as examples of sustainable resource use which could act as examples to motivate the participants. Days in the country (*días de campo*) were also organized where farmers could meet to compare their experiences and the results of their CARE-PROMUSTA initiated projects (CARE 1996b). CARE-PROMUSTA also created and distributed practical materials to the community members.

Most of the key informants mentioned that CARE was very successful in their training program. This feeling is summed up by one former extension worker,

> *The projects of CARE were successful because of the training. CARE trained us in all of the part –nurseries, transplanting, transportation, management, maintenance, and harvest.* (8305).

While most agree that CARE's training program was successful, greater differences appear concerning the overall success of CARE's work in Saraguro. I will highlight the two extremes of the viewpoints expressed to emphasize the differences of opinion. On the positive side, a number of local Saraguros who had worked for CARE paint a picture of a people who did not value trees or the forest before CARE had come. In this scenario, CARE brought enlightenment to an ignorant people. "In the past the people didn't value the forest at all – they cut and burned almost all of the forest to make pasture" (8304). Another informant while talking about the successes of CARE's work and if people are still using the CARE initiated projects, had this to say:

> *The people have not destroyed these systems because they have learned the value of these things. If they had not learned from CARE to value these trees they would have taken their machetes and cut it all down because before they didn't value it and now they do. In all, the people of Saraguro are better off now. They have their gardens and improved pastures. They can go to market and sell their produce – they have ways to make money. So, the end result of these [CARE] projects has been good more or less* (2308).

At the other extreme, are those who saw CARE as ignorant outsides who did not know what was best for the people. In this view, it was the locals who knew what was best for the land and at best tolerated CARE's intrusion. They put up with CARE's games as they would a child:

> *The projects of CARE were just an experiment. They said we should plant pine trees – that pine trees are good for wood and firewood. But in reality, pine don't serve any purpose. This experimentation of CARE was not successful. Pine are useless here. The wood is not good and the plantations are far away from the communities – so how are we supposed to get the wood in the first place* (1304).

Another respondent said,

> *I learned a lot from CARE but not all of their information was correct. CARE wasn't all that good for us here. CARE told me one thing by my experience told me something different* (1103).

These two extremes emphasize the fact that there are opposing viewpoints within the indigenous Saraguro population. Reactions and opinions cannot be understood at a community level, but communities must be understood as made up of any number of views and opinions. Underneath and more significant to this study than the reactions to outsides influence is the process of how any one community member incorporates these new practices and technologies within their existing systems. The process of adaptation through the incorporation and rejection of elements from outside systems is the process of cultural evolution. This process will be discussed in detail in the next section; for now it is important to recognize that this process is at work. CARE left Saraguro in 1996 and projects that they started have been going for eight years without their intervention. This has given me an opportunity to witness this process of adaptation. How are the projects now? Are they still being used? Have they been changed to fit the needs / wants of the people? These were questions I asked and observed while in Saraguro. One informant got to the heart of the matter:

> *Now they [the people] are not doing them [the CARE projects] like they used to before. Before the projects were going well and now at the very least they are being maintained. Some have continued to plant trees for hedge rows and living fences, others have planted trees around their crops and on their land – one here one there – so their land isn't desolate. I have seen that this is very personal to the landowner. They are not being assisted any more so they are making their own decisions* (2308).

If this process of adaptation can be seen on the side of the Saraguro landowner, can it also be witnessed on the side of CARE? How did CARE change and adapt as a result of their encounter with the people of Saraguro? Based on internal evaluations of CARE and through key informant interviews, I believe there is evidence to support that CARE did indeed adapt and modify their interventions as a result of knowledge (insights) gained through interactions. I will limit this discussion to two examples.

In establishing agroforestry systems in Saraguro, CARE first did a study on existing agroforestry systems in the area (Carlson and Ronceros 1987; Carlson and Vieira 1992). They found that some traditional systems did exist and these took the form of (1) small clusters of trees / shrubs on land that could not be used for crops or pasture; (2) hedge rows and living fences; and (3) fruit trees in homegardens. The study recommended promoting these systems with two additional strategies (Carlson and Ronceros 1987). One of the additional strategies they recommended was a silvopastoral system of randomly placed trees within the pasture. They initiated a number of these systems but in a later evaluation recommended discontinuing the practice (CARE 1991).

While studying traditional agroforestry systems, CARE discovered that a number of households in six communities were utilizing a non native tree in their hedge rows and homegardens. This tree was actually two species of the *Erythrina* genera that is native to South America but not to Saraguro. CARE decided to grow this tree in their

nurseries and promote its use in its agroforestry projects. But their propagation techniques (seeds and small diameter cuttings) only achieved a 2% survival rate (Carlson and Vieira 1992). Because of these bad results another study was undertaken to understand how the *Erythrina* species have been propagated traditionally in Saraguro. This study included eight communities, 65 households, and 127 people (Carlson and Vieira 1992). They found that the trees have been propagated in the Saraguro area for at least 200 years (I listed them as a possible Incan arrival). They do not reproduce naturally in Saraguro but must be propagated by humans. The preferred traditional method was with large cuttings (1.5-2 m long and 8-20 cm diameter) with small wounds made at the bottom to stimulate root growth. The cuttings are placed directly into the ground (Carlson and Vieira 1992). As a result of this study, CARE incorporated this propagation method and had much better survival rates (Carlson and Vieira 1992).

These two examples show CARE's willingness to learn from and adopt traditional practices. An analysis of internal documents (CARE 1990; CARE 1991; CARE 1994a; CARE 1994b; CARE 1996a; and CARE 1996b) show that CARE continually evaluated their work and sought to modify their interventions to better fit with local traditions and practices and that they were willing to learn from the people they came to help. This dual process of adaptation along with other significant patterns uncovered in these findings will be explored further in the discussion section that follows.

D. Summary of findings

Farm tree and agroforestry patterns in the Saraguro basin are best understood as being similar within broad constraints, but highly individual as to how the components are arranged on a unit of land. Household interviews and participatory mapping

revealed that land-use types can be classified into six main categories (homegarden, field agriculture, pasture, plantation, greenhouse, and native forest / shrub land). These are all of the land-use types found in the Saraguro basin. The distribution of these six main types is similar also. Homegardens are always found in the residence land-unit. Field agriculture land-units and greenhouses are close to the home usually within or directly outside the community (in any case they are never found above 2850m). Pasture land-units are further from the communities usually between 2700-3000m. Plantations and shrub-land are found both within the community and in the hills surrounding the community, but they are always found on land that cannot be used for pasture or crops. Native forests are found far away from the communities at higher elevations on land that is usually too steep, too far, or too high for other uses. There are of course exceptions to this general rule, but this is the overall pattern of land-use types.

These similarities begin to make sense when understood in the larger social-ecological-historical context in which they are found. The homegarden, corn, cattle livelihood strategy is in part determined by the agroecological zones found in Saraguro, historic elements taken from Incan and Spanish occupation, the completion of the Pan American Highway, and the interventions of CARE. All of these factors helped to shape the overall livelihood strategy of the Saraguros today.

Each household makes choices in how they will pursue their livelihood strategy. A household's livelihood strategy will to a large extent determine how and why they use trees. A number of factors have been identified that help to explain tree use patterns and practices. Key site characteristics was important because all land suitable for agricultural or cattle production will be used as such and trees will have to conform to these dominant land-use types. But where land cannot be used for these purposes

trees will almost always be found. Site characteristics also help to determine what species of trees will be planted. Some of the main quality issues found were if the location was wet or dry, elevation, and soil quality. Food / firewood / construction material self-sufficiency were also found to be important factors to household tree use. Trees were mainly used for these three purposes and every household spoke of an interest in trying to maintain a level of security and self-sufficiency in regards to fruit and wood. Individual choices on how to engage the market economy were found to be important factors influencing tree-use. Household market engagement strategies influenced tree species and patterns. Market engagement strategies in fruit production, guinea pig raising, textile production, and medicinal plant production were all found to influence how and why households have trees on their land. These three factors more than any of the others looked at in this paper were found to be important influences in household tree use. All of the factors interact and compete with one another on the household level. Households must make trade-offs and face tensions between all these factors. Each household acts and reacts differently to the different situations presented. In this sense, tree use can only be understood at the level of the household because of the complexity involved.

VI Discussion

This section will explore how households use their multiple land-units to develop an overall livelihood strategy and how trees fit into to that strategy. Second, it will look at the issues of resilience and adaptation. Last, it will discuss the meaning of the encounter between the people of Saraguro and CARE and explore its significance for the understanding of cultural evolution.

A. Household livelihood Strategies

The livelihood strategies of the Saraguros were shown to be a mixture of subsistence and commercial activities. Most households fall somewhere in the middle in regards to level of subsistence and commercial activities. All households have a land base on which they practice some degree of subsistence agricultural production and most also raise cattle for the market. Since the 1970's there has been much more diversification in livelihood strategies often in the form of increased market engagement. This includes both on-farm market activities and off-farm employment. Diversification has been a key strategy for the Saraguros. Much of their livelihood strategy is based on their secure land tenure.

The changing livelihood strategies of the Saraguros have affected tree-use patterns and practices in the basin. The pursuit of commercial cattle production led to large scale conversion of forests to pasture. Since the 1970's, there has been an increase in tree planting on farms. Trees on farms have generally conformed to the pre-existing land-use types. Trees found their way on to residence land-units (mainly in homegardens), field agriculture land-units, and pasture land-units. But since the 1980's a new type of land-unit came into existence with the help of international NGOs and government ministries – the plantation. The efforts of CARE more than any other

organization helped to shape tree use patterns and species. In terms of livelihood strategies, what CARE did was even the playing field in regards to tree planting. Though their programs and projects they made new species of trees available to all regardless of social or economic status. Trees were available to everyone for free in exchange for planting pine trees on communal land or were sold at a very low price. With new fruit trees and vegetables, CARE helped to diversify both the subsistence and commercial aspects of the Saraguro's livelihood strategy. Now most households grow fruit trees and vegetables for subsistence use while some households have begun to sell these products at the local and national levels. CARE needs to be understood as one of the key factors influencing tree use patterns and species in the basin. They helped to completely change the landscape by making their tree species and technical knowledge available to most everyone.

While CARE helped influence tree-use and in turn livelihood strategies, their presence in Saraguro is not enough to explain the variation in tree use on the household level. CARE left Saraguro in 1996 and since then the Saraguros have been building upon CARE's foundation and abandoning aspects of CARE's work. This paper has been concerned with the livelihood strategies of the Saraguro. CARE's work should be understood as one factor influencing the livelihood strategies of the Saraguros.

This study has sought to uncover patterns or themes in tree use among the Saraguros of Southern Ecuador using household livelihood strategies as its analytical framework. So what are those patterns or themes? On the one hand the overall tree use patterns and practices have been explained by the larger context. In understanding the ecology, history, culture, and economics I have explained the overall livelihood strategy of the homegarden, corn, cattle livelihood strategy. But I am

also concerned with tree use at the household level and explaining the variation between households. Do any patterns exist between a certain set of households with the same characteristics and tree-use? I must conclude that it is impossible to generalize above the level of the household. There is no way to say exactly what a household will do based on some set of characteristics. It is at the level of the household where the various factors play out. The trade-offs and tensions occur at the level of the household. Household decisions are based on a number of factors only some of which are outlined in this paper.

In regards to understanding tree-use, the three most important factors uncovered were quality of land, security and self-sufficiency, and how a household chooses to engage the market economy. Key site characteristics were found to be important in terms of determining where trees would be within each land-use system. It was also helpful in understanding what types of trees would be used in a given area. Key site characteristics are much more useful than size of landholdings in determining how and why households use trees. Security and self-sufficiency was also a key factor in understanding tree-use. The Saraguros pursue a livelihood strategy based in part on food, firewood, and wood security / self-sufficiency. Trees played a role in food security in that every household had fruit trees. Fruit production was listed as one of the most important roles of trees on a household level. Trees also were grown for firewood and construction material. Every household grew trees mainly for firewood and construction material. Having a secure supply of both and not having to buy either was found to be an important part of the Saraguros livelihood strategy. How a household chooses to engage the market economy will also influence tree use. Market engagement can be understood as both on-farm commercial production and off-farm employment but off-farm employment was not found to be an important factor

in determining if or how a household uses trees. Much more important in term of understanding tree use was on-farm commercial production. On-farm commercial production will influence tree species and patterns. In Saraguro it was shown that commercial fruit tree production, guinea pig production, textile production, and medicinal shrub production all influence tree use. Each one of these factors are important in understanding tree use on a household level, but it is in the combination and interplay between them that lead to household decisions concerning tree use. No one factor can be looked at in isolation and the factors outlined here are also influenced by the other factors discussed in the findings and with the larger social-ecological-historic context. It is the dynamic interplay between all of these factors that explains a household's livelihood strategy. These three factors outlined here should be understood as a set of guidelines, rules of thumb, or indicators that can be used to understand tree use at the level of the household.

B. Resilience

Because there have been many changes in only the last 60 years, they have not gone unnoticed by the land-owner. The older members of the communities I worked in were particularly perceptive in verbalizing the changes they have witnessed and their meanings. In recalling the past, one respondent told me:

> *36 years ago there was a tremendous* (*tremendo* also means awful or dreadful*) forest, but the people cut it all down to make more pasture for more cows* (1301).

An older woman makes the connection between the construction of the Pan Am and deforestation almost subconsciously and goes on to pinpoint the reasons for the changes following the deforestation:

> *There was deforestation because of the construction of the highway. 30 years ago there were no eucalyptus. But now there are a lot of eucalyptus*

and pine. The changes in the tree species were because of the organizations CARE and MAG (Ministry of agriculture and livestock) (1303).

An older gentleman captured it best when he said, "Now Saraguro has a new face with exotic trees" (1304). This statement perfectly captures the concept of an NGO landscape – meaning that the visible features of a landscape have been so totally transformed by an NGO's interventions as to be easily recognizable (Knapp 1994; Sundberg 1994; Keese 1998).

On the landscape and community level, the effects of CARE's work are visually recognizable. It has already been seen that CARE has, more than other institutions, influenced tree species composition change and vegetation patterns in the Saraguro basin. They propagated and distributed tree species of their choosing and helped to arrange them on the land. But while species composition was largely due to CARE's work, which of those trees were used and how they were individually arranged on any one parcel was largely up to the landowner. Tree patterns and practices on a landscape level have been shown to conform to the overall homegarden, field agriculture, pasture livelihood strategy pursued by most Saraguros. This is summed up perfectly by one respondent,

The main uses of the land for the people are in agriculture and cattle. So they have most of their trees in places that they cannot use for agriculture or cattle raising – like steep places and undesirable places. The people know where to plant trees (2308).

This livelihood strategy is built on the access to a secure land base. It was shown in the context section that the Saraguros have had secure land tenure for at least 250 years. From this secure land base they have developed over the last 60 years a livelihood strategy of subsistence agriculture combined with commercial cattle production. This strategy developed in response to new access to regional markets as the result of the completion of the Pan American highway through Saraguro. The

Saraguros responded to this change by expanding their livelihood strategy. This diversification marks the Saraguros initial integration into a market based economy. The Saraguros adapted to the change by adding a new element while retaining their subsistence agricultural base. They did not abandoned wholesale their previous practices but rather maintained the security of their subsistence base while adding commercial cattle production on land that was not under production.

This strategy of diversification is a key aspect of the Saraguro's livelihood approach. Complex social-ecological systems theory says that new properties will emerge in a system that cannot be predicted (Scoones 1999). Systems respond through adaptation and resilience (Holling 2001; Berkes 2003). In this case, the Saraguros responded to the emergence of new markets by adapting their livelihood strategy to best exploit this new property. But even as they adapted they showed resilience through their retention of their subsistence agricultural base. Commercial cattle production built upon this base it did not supersede it. Diversification is an important aspect of resilience for the Saraguros. As a strategy, diversity increases security by spreading the risks of failure among more than one component. Maintaining a subsistence agricultural base has been a key aspect of security in the Saraguros livelihood strategy. From this secure base, the Saraguros are able pursue limited market engagement and experiment with new market strategies without the fear of having nothing to fall back on. This subsistence base gives the Saraguros a level of resilience and allows them more room to adapt and change to new opportunities.

Since the 1970's, diversification of livelihood strategies have responded to new markets and new opportunities. Saraguros are not only diversifying their agricultural base to include more market activities, but are also taking advantage of new off-farm

employment opportunities. 51% of respondents indicated they had off-farm employment. This has taken the form of teachers, local government employees, carpenters, lawyers, and doctors. Off-farm employment was found to decrease food self-sufficiency in some households. Off-farm employment should be viewed on a continuum. The lowest level on the continuum being where one member of a household engages in part or full time employment locally. This allows for the agricultural base to be maintained. On the other end of the continuum there are households were both parents have full time local off-farm income or one or both parents have employment in other parts of the country or even in other countries. With these new off-farm strategies some Saraguros have abandoned the homegarden / corn / cattle livelihood strategy all together. But more often, the land base is kept and off-farm employment is seen as an addition to the homegarden / corn / cattle strategy.

The Saraguros have been diversifying their agricultural base since the 1980's and 1990's. This paper has shown how changing livelihood strategies have affected household tree-use. Households have continued to adapt to changing conditions and new market opportunities while maintaining a level of resilience. Since 1998 cattle production has become a lot less lucrative because of dollarization. A few families have stopped raising cows altogether while others have reduced cattle raising to more of a subsistence activity. Yet commercial cattle production is still practiced by 62% of households.

Household tree-use has changed with the changing livelihood strategies of the Saraguros. First, beginning in the 1940's with commercial cattle production, the Saraguros converted forested land to pasture. An unintended consequence of this new livelihood pursuit was a drastic decline in firewood and construction material

supplies. With the help of CARE and others, the Saraguros responded to this decline by planting more trees on their farms. But the species chosen and their arrangement on farms reflect the individual household's livelihood strategy. Trees conform to the size and quality of the landholdings, the desire for fruit, firewood, and construction material security and self-sufficiency, and new market engagement strategies. Today Saraguros have more fruit trees for household needs and for sale in local markets. These fruit trees have been incorporated into their homegarden system and as such demonstrate this balance between adaptation and resilience. Others have pursued commercial guinea pig production and use trees as an important part of their forage grass production systems in homegardens. Still others have started selling textiles and their homegardens reflect the need for tree and shrub derived dyes. Some Saraguros have incorporated trees in their field agricultural systems using mainly exotic species brought by CARE. Many households have adopted the plantation systems of CARE to meet their firewood and construction material needs and with the hope of selling surplus trees. And most have continued to keep trees along the boundaries of their pasture land only now the main species of eucalyptus, pine, and aliso reflect CARE's interventions. From the Saraguro's perspective, CARE's interventions have been just one more way they can add diversity and security to their livelihood strategy.

C. Cultural Evolution

The preceding section helps to explain tree-use within the changing livelihood strategies of the Saraguros. Diversity is key to security and trees play a role in diversification. In this section, I want to explore the larger meaning of this project. Where does the importance of this study lie? This study, focusing on Saraguro

between 1983 and 2004 encompasses the lifespan of CARE in Saraguro. I have had the unique opportunity to see the results of this encounter. CARE worked in Saraguro for 13 years and helped to change the landscape as much as the Pan American Highway did 60 years before. What is to be learned from this encounter between an International NGO and an Indigenous Group in the highlands of Ecuador?

Cultural ecology with its focus on understanding the adaptive strategies of groups when faced with change provides a framework for exploring this encounter. Recent work in political ecology, environmental history, and ecological economics provides a more nuanced understanding that is helpful in dealing with complex socio-environmental issues (Scoones 1999; Holling 2001; Berkes et al. 2003). A number of themes outlined in the theoretical framework can be applied here. First, in understanding knowledge systems, we need to move beyond simplistic dichotomies of indigenous / western; inside / outside to an understanding of the existence of various types of knowledge systems (Agrawal 1995; Watts 2000). This view places an emphasis on recognizing the similarities and differences between and within so called traditional and scientific knowledge systems. With this view, the encounter between the people of Saraguro and the people of CARE is not one where two totally separate, distinct, and closed knowledge systems collide and compete; but rather of an encounter of two open and dynamic systems of knowledge that have particular histories and logics where similarities exist between the two and within each are found competing views.

This perspective allows us to see that the present day ideas, beliefs, practices, and meanings of the Saraguros comes from a long history of adaptation and change. Their knowledge systems are a mishmash of elements from pre-Incan, Incan, Colonial, Catholic, and modern sources. Variability exists within their knowledge

systems yet as a self-identified ethnic group they have maintained a level of resiliency. They have persisted as an identifiable group through a dynamic process of resistance and change – incorporating new elements while retaining their identity. Their encounter with CARE allows us to see this process as it happens. They were ready partners with CARE in transforming the landscape. The need for wood products closer to settlements and their desire to improve pasture conditions, made them willing recipients and co-managers of reforestation efforts. There is no doubt that they have benefited from these projects as seen by the fact that eucalyptus was named the most important tree for house construction and firewood by a majority of respondents. Yet, they did not just adopt wholesale the knowledge and practices of CARE. This is seen in the number of respondents who questioned CARE's knowledge about the benefits of certain tree species for their pasture and crops (i.e. pine and acacia). It is also interesting to note that the only wholesale adoption of an outside system (i.e. pine plantations) received the most negative criticism. Besides pine plantations, the Saraguros incorporated trees into their pre-existing systems based on their wants and needs. Trees went into their homegardens, pasture and field agriculture land-units. Competing views within the Saraguro's knowledge system were seen by the two opposing views of the overall success of CARE's work. In the one view, locals were seen as ignorant needing to be taught the value of trees. The other view, saw CARE as misguided at best, and stupid at worst thinking it knows best – whereas the locals in a wise adult-like fashion put up with their antics.

Another important theme to our present discussion relates to the understanding of knowledges discussed above but allows for a more complete analysis of CARE's role and perspective. An understanding of the concept of institutions as outlined by Agrawal (1999) and others (Scoones 1999; see theoretical framework for review) is

helpful to this discussion because it creates space for viewing institutions as multistranded, local and non local; formal and informal, and how institutional interactions can lead to landscape change. Patterns of authority are "inscribed on the landscape and [are] reflected in ecological patterns and processes" (Scoones 1999 p.494). The interactions between CARE and the local institutions of the Saraguro indigenous group (informal), community governing structures (formal), local interest groups (both formal and informal), and households (informal) drastically changed the landscape. The interplay between these groups (all active and willing participants) affected change in vegetation composition and patterns on the landscape level. Inherent in this change in relation to the extent of the impacts are the various levels of authority involved. CARE can be seen as having a high level of authority in these interactions. They came with the resources, the project ideas and the mandate. Yet each community council officially invited them to work in their community and as such can be seen as having a high level of authority. The community government body as a whole gave the go ahead to plant large tracts of community land with pine. Households were invested with lower levels of authority in that they could choose to work with CARE to initiate projects on their land or not work with CARE. And if they did not want to work with CARE they could still get trees from them. They also had a say in what projects they wanted to initiate and what trees species they wanted to use.

The particular history and logic of CARE's knowledge base is another important aspect of CARE as an institution. CARE as an institution evolved and changed in relation to the overall scientific / development climate it was operating in and because of its encounter with the people of Saraguro. CARE's focus on large scale pine plantations on community lands reflected the dominant discourse in international development circle at the time. The early 1980's was a time when the ideologies of

modernization were crumbling and a new focus on community forestry was just beginning (Arnold 1991; Laarman and Sedjo 1992). As a result of the failures encountered with many of these projects, new directions were taken that focused on the household. This is seen in CARE's abandonment of large scale reforestation efforts at the end of 1988. The CARE-PROMUSTA phase reflected the current emphasis on agroforestry and soil conservation. It also reflects the trend in development thinking to a more participatory project design. The evolutionary nature of CARE as an organization can also be seen in the changes they made in programs based on feedback from local actors. They researched traditional agroforestry systems in the area and then implemented their systems based on traditional practices like hedgerows and fruit trees in a homegarden system. They incorporated the Erythrina species into their agroforestry design when they found it already being used in some communities. And when they had trouble propagating it, they turned to the landowners for help. This should be enough to show that, like the Saraguros, CARE went through an evolutionary process as a result of the encounter. Far from being one-dimensional and monolithic, CARE deserves the same level of critical analysis that has usually been reserved for the treatment of local / traditional / indigenous groups.

VII Conclusion

Saraguro has had a long history of land-use where both people and the environment have coevolved together. Due to its heavy forest cover and cold wet climate, the Saraguro basin was colonized late in relation to other places in the Andes. The first groups probably colonized the Saraguro basin in response to increased warfare in the area around 500A.D. They utilized the ridge tops and hillsides to provide security from other groups. Since the Incan times, the Saraguro basin has felt the effects of "outside" or "foreign" influences. Saraguro has been part of a State ever since. Both the Incas and the Spanish colonists brought with them new peoples, technologies, practices, customs, religions, and languages. From the Incas they inherited a culture based on the corn/ bean/ squash trinity and from the Spanish they inherited the sheep and the cow. These elements have become defining characteristics of the livelihood strategies of Saraguros today. The Saraguros survive today with their land base intact because of the State policy of the *tambo* service. It is from this secure land base that the Saraguros were able to develop their present livelihood strategy of the homegarden, field agriculture, and cattle raising.

More recently, the completion of the Pan American Highway through Saraguro can be singled out as a defining event in the history of land-use and land-use change in the basin. This event set the stage for the present situation. The end of the tambo service and the opening of new markets allowed the Saraguros to pursue the dual livelihood strategy of subsistence agriculture with cattle production for the cash economy. Widespread cattle production led to rapid deforestation of the land surrounding primary settlements. The deforestation of the basin drew national and international attention in the form of Government Ministries and international NGOs.

From these encounters, the valley has been reforested with a number of non native species and new types of fruit trees, vegetables, and pasture grasses. Most of this change has occurred in just over the last 60 years. But these recent changes need to be understood as one set in a long line of changes. In the Saraguro phase (500A.D), deforestation occurred on the steep hillsides, while drastic changes in ethnic make-up most likely occurred with the Incan practice of forced resettlement. The colonial introductions of cows, horses, sheep, goats, and pigs likewise, had a considerable impact on local ecology.

The present study takes place within this latest context of change. Livelihoods have diversified from ones based strictly on corn and cattle to ones that pursues multiple market engagement strategies. Today, the five main land-use types in the basin are the residence, field agriculture, pasture, plantation, and forest / shrub land-units. Trees are incorporated into all of these land-units and are arranged in rows, clusters, or randomly. Trees are used mainly for their productive uses of firewood, construction material, and fruit. They also are valued for their protective uses of windbreaks / living fences, nitrogen fixing, leave litter, shade, and moisture retention. Trees contribute to food, firewood, and construction material security and self-sufficiency and are used in a number of market engagement strategies including fruit production, guinea pig production, textile dyeing, and medicinal plants.

Species composition has been largely influenced by international NGOs and state agencies. CARE has played the largest role in reforestation with 13 years of projects ranging from pine and eucalyptus plantations, to fruit tree and pasture improvement projects. The Saraguros have incorporated these trees into their livelihood strategies and have made the CARE projects their own by integrating them into their own land-use types.

This paper has argued that to understand how households use and manage trees you have to understand the household's livelihood strategy. Livelihood strategies include factors from multiple levels of scale including the larger social-ecological-historical context and the individual factors that influence household decisions. A key aspect of the Saraguro's livelihood strategy is diversification. Diversification reduces risk and contributes to the sustainability of a livelihood strategy. In this sense, sustainability is a process where a household adapts and changes with the changing social-ecological system. Since Incan times, the Saraguros have maintained a level of resilience and resistance to the forces of change. They have incorporated many outside elements while at the same time retaining a continuity that allows them to be distinguished as a distinct indigenous group today.

A. Recommendations

There are a number of implications that can be drawn from this study. In trying to understand human-environment interactions and how households adapt when faced with change, this study recognizes that social-ecological systems are dynamic and complex. These systems are not linear and do not follow any set patterns (Scoones 1999). Within these systems there is always a level of uncertainty; therefore outcomes cannot be predicted and interventions to manage or control these systems become problematic. What implications does this new understanding have for future development work? When uncertainty, complexity, and change are the norms then,

> Knowledge of the system[s] we deal with is always incomplete. Surprise is inevitable. Not only is the science incomplete, the system itself is a moving target" (Holling 1993:553).

In this world, science in general and development agencies in particular will not be able to control or predict outcomes. If science is by nature incomplete then

perceptions become key (Scoones 1999). Other perceptions and knowledge systems become important avenues to explore because they may offer insights critical to the issue at hand. This understanding in turn opens the process of problem solving to all interested parties. Institutions, local and non, become co-designers, co-implementers, and co-managers of programs and policies. For tree based development programs this means adopting a participatory approach from the beginning. This entails letting the participants define the problem and working with them to find solutions. With regards to trees this would mean letting them decide what they want the trees for and what species of trees they want. This is potentially problematic for development organizations because it entails a loss of power. What if the participants do not want trees but some other form of intervention? What if their objectives are different from the organizations? This may mean redefining the role and purpose of development organizations. But in doing this I believe that space would be opened for genuine dialogue. Scientific and local knowledge could combine forces in problem solving and similarities and differences could be examined and tested through experience. Empowerment would become central. This is not to say that development organizations should not do their homework. Science would still be a useful tool, just not the only tool. In this framework, multiple perspectives and methods of investigation would be encouraged. On the science end, this would entail interdisciplinary studies of both social and ecological systems.

In dynamic systems defined by complexity and uncertainty, development initiatives must be seen in terms of what has been called "adaptive management" (Holling 2001). The key point here is that development programs must maintain the ability to adapt to change. Adaptive management assumes change and uncertainty and incorporates a high level of flexibility into programs and policies. This conception sees sustainability

as a never ending process that adapts and continually seeks to renew itself through restructuring and resilience (Holling 2001; Berkes 2003).

What does adaptive management look like on the ground? How can it be operationalized? This is where future research needs to be focused. Guidelines and procedures need to be developed and tested. Projects based on these guidelines need to be implemented and monitored over many years. This is the way forward for recent work based on participatory models is lacking the rigor and structure necessary for implementation on the policy level.

In Saraguro, adaptive management would start with participatory research, planning, and design. While CARE allowed a certain level of participation, their programs were not truly participatory as defined by Chambers (1983) and others (Cohen et al. 1980; Chambers et al. 1989; Rocheleau 1991; Thrupp et al. 1994). CARE came to Saraguro with the preconceived objective of reforestation and with a number of exotic tree species that they chose. In a truly participatory approach, CARE would have allowed local participation in coming up with the projects and what species to use (if in fact they wanted reforestation).

In regards to the selection of tree species, CARE would have done better by dedicating more time to experimentation with both natives and exotics. It was shown that the pine plantations were the least successful of their projects. The negative effects could have been reduced if CARE had experimented with pine on a small-scale and gotten feedback from the locals. The case of eucalyptus is more complicated. Eucalyptus has become the tree of choice for most Saraguros. Eucalyptus have negative impacts on the land yet they are taking pressure off the native forests. Would the Saraguros have chosen eucalyptus in a participatory scenario without having known much about them? In an ideal setting CARE would

have experimented with many tree species and left it to the locals to decide which species they wanted. But given the time frame involved in trees reaching maturity, this may be impractical. Yet, adaptive management on the part of the Saraguros was seen in the case of eucalyptus and other exotic trees. The Saraguros experimented with the various tree species available and based on their experiences decided which species to continue to use (eucalyptus and aliso) and which ones to abandon (pine and acacia). They also learned where to plant the trees to have the least negative effects.

The key to adaptive management is not getting everything perfect the first time around but to be open to feedback and able to change course based on that feedback. Because of the complexities involved in social-ecological systems, any development intervention is going to have problems and over time things will change. The key is for projects to be open and flexible to change. When projects begin with full participation from locals and have built in mechanisms for dealing with change then projects will be a lot more likely to succeed.

VIII Appendix

Productive Uses Key

Cm = Commercial
Or = Ornamental
Fd = Food
Fw = Firewood
Md = Medicine
Dy = Dye
Fg = Forage
Cn = Construction Material
Ft = Furniture
Ps = Posts
Tl = Tools

Protective Uses Key

Wb = Windbreak
Lf = Living fence
Hu = Moisture retention
Nt = Nitrogen fixing
Fl = Fertilizer
Fn = Filtration
Sh = Shade
Sc = Soil Conservation

Species and Productive Uses

Common Name	Genus / Species	Cm	Or	Fd	Fw	Md	Dy	Fg	Cn	Ft	Ps	Tl
Acacia	*Acacia dealbata* *A. mearnsii*				X	X					X	
Aguacate	*Persea Mill sp.*	X		X								
Aliso	*Alnus jorullensis* *A. nepalensis*				X	X	X		X			X
Babaco	*Carica pentagona* *Heilborn*	X		X								
Cafe	*Coffea arabica*			X								
Caña de Azucar	*Saccharum officinarum*			X								
Cañaro	*Erythrina spp.*							X			X	
Capuli	*Prunus sertina*			X	X		X		X		X	
Cedro	*Cedrela sp*											
Cedron	*Lippia citriodora*			X		X						
Cipre	*Cupressus macrocarpa*				X	X			X			
Chilca	*Baccharis spp.*				X							
Chirimoya	*Anona sp.*											
Duco	*Clusia spp.*				X				X			
Dumaril	*Fam. Melastomataceae*					X						
Duraznillo	*?*				X				X			
Durazno	*Prunus persica L.*	X		X								
Eucalipto	*Eucalyptus globulus* *E. saligna*	X			X	X			X		X	X
Floripondio / Wando	*Brugmansia spp.*					X						
Gañil / Cucharillo	*Oreocallis spp.*					X						
Granadilla / Taxo	*Passiflora edulis*			X								
Guaba	*Inga sp.*	X		X								
Guato	*Erythrina edulis*			X	X			X				
Higo	*Ficus carica*			X		X						
Laurel	*Myrica pubescens* *M. macrocarpa*	X			X	X	X		X			
Lechero	*Euphorbia laurifolia*											

Common Name	*Genus / Species*	Cm	Or	Fd	Fw	Md	Dy	Fg	Cn	Ft	Ps	Tl
Limón	*Citrus limonum L.*	X		X								
Luma	*Pouteria lucuma*			X	X							
Malva	*Althaea rosea*					X						
Mandarina	*Citrus reticulata*			X								
Manzana	*Rosaceae sp.*	X		X								
Marco	*Franseria artemisiodes*											
Matico	*Piper angustifolium*					X						
Membrillo	*Cydonia vulgaris*			X								
Mora	*Rubus sp*			X								
Mullon	*Podocarpus montanus*				X				X			
Naranja	*Citrus aurantium*			X								
Nogal	*Juglans spp.*			X		X	X		X			
Palma	*?*			X								
Pena Pena	*Fuchsia L. sp.*					X						
Penco	*Agave americana*			X		X		X				
Penco Blanco	*Fourcroya sp.*											
Pera	*Pyrus communis*	X		X								
Pino	*Pinus radiate* *P. patula*				X				X	X	X	
Puckik	*?*					X						
Pumamaqui	*Oreopanix sp.*											X
Quishuar	*Buddleia sp.*											
Reina Claudia	*Prunus salicina*	X		X								
Romerillo	*Romerillo oleifolius*				X				X			
Romero	*Rosmarinus officinalis*		X			X						
Sacha Capuli	*Rapanea andina*				X				X			
San Pedro	*Trichocereus pachanoi*					X						
Sarar	*Weinmannia spp.*				X				X			
Sauce	*Salix alba* *S. humboldtiana*				X	X	X				X	X
Sauco	*Cestrum auriculatum* *Sambucus peruviana*					X						
Tobaco	*Nicotiana L. sp*					X						

Common Name	*Genus / Species*	Cm	Or	Fd	Fw	Md	Dy	Fg	Cn	Ft	Ps	Tl
Tomate de Árbol	*Cyphomandra betacea*	X		X								
Toronche/ Siglolon	*Carica crassipetala*	X		X								
Tuna	*Opuntia ficus-indica*			X			X					

Species and Protective Uses

Common Name	Genus / Species	Wb	Lf	Hu	Nt	Fl	Fn	Sh	Sc
Acacia	*Acacia dealbata* *A. mearnsii*	X	X		X	X			X
Aguacate	*Persea Mill sp.*								
Aliso	*Alnus jorullensis* *A. nepalensis*	X	X	X	X	X		X	X
Babaco	*Carica pentagona Heilborn*								
Cafe	*Coffea arabica*								
Caña de Azucar	*Saccharum officinarum*								
Cañaro	*Erythrina sp.*	X	X			X			
Capuli	*Prunus sertina*	X							
Cedro	*Cedrela sp*								
Cedron	*Lippia citriodora*								
Cipre	*Cupressus macrocarpa*	X							
Chilca	*Baccharis sp*		X						
Chirimoya	*Anona sp.*								
Duco	*Clusia spp.*								X
Dumaril	*Fam. Melastomataceae*		X						
Duraznillo	?								
Durazno	*Prunus persica L.*								
Eucalipto	*Eucalyptus globulus* *E. saligna*		X				X		X
Floripondio / Wando	*Brugmansia spp.*								
Gañil / Cucharillo	*Oreocallis spp.*		X						
Granadilla / Taxo	*Passiflora edulis*								
Guaba	*Inga sp.*								
Guato	*Erythrina edulis*	X	X	X	X	X		X	X
Higo	*Ficus carica*								
Laurel	*Myrica pubescens* *M. macrocarpa*		X						X
Lechero	*Euphorbia laurifolia*		X						

Common Name	*Genus / Species*	Wb	Lf	Hu	Nt	Fl	Fn	Sh	Sc
Limón	*Citrus limonum L.*								
Luma	*Pouteria lucuma*								
Malva	*Althaea rosea*								
Mandarina	*Citrus reticulata*								
Manzana	*Rosaceae sp.*								
Marco	*Franseria artemisiodes*		X						
Matico	*Piper angustifollum*								
Membrillo	*Cydonia vulgaris*								
Mora	*Rubus sp*		X						
Mullon	*Podocarpus montanus*								X
Naranja	*Citrus aurantium*								
Nogal	*Juglans spp.*		X						
Palma			X					X	
Pena Pena	*Fuchsia L. sp.*								
Penco	*Agave americana*		X						
Penco Blanco	*Fourcroya sp.*		X						
Pera	*Pyrus communis*								
Pino	*Pinus radiate* *P. patula*	X	X						
Puckik	*?*		X						
Pumamaqui	*Oreopanix sp.*		X						
Quishuar	*Buddleia sp.*		X						
Reina Claudia	*Prunus salicina*								
Romerillo	*Romerillo oleifolius*								X
Romero	*Rosmarinus officinalis*								
Sacha Capuli	*Rapanea andina*								
San Pedro	*Trichocereus pachanoi*		X						
Sarar	*Weinmannia spp.*								X
Sauce	*Salix alba* *S. humboldtiana*	X	X			X	X		
Sauco	*Cestrum auriculatum* *Sambucus peruviana*								
Tobaco	*Nicotiana L. sp*								

Common Name	*Genus / Species*	Wb	Lf	Hu	Nt	Fl	Fn	Sh	Sc
Tomate de Árbol	*Cyphomandra betacea*								
Toronche/ Siglolon	*Carica crassipetala*								
Tuna	*Opuntia ficus-indica*		X						

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