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Dispersed Tree Agroforestry In Eastern El Salvador: Local Farmer Knowledge And Management Practices For Preferred Species Of An Indigenous Agroforestry System

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DISPERSED TREE AGROFORESTRY IN EASTERN EL SALVADOR: LOCAL FARMER KNOWLEDGE AND MANAGEMENT PRACTICES FOR PREFERRED SPECIES OF AN INDIGENOUS AGROFORESTRY SYSTEM

By

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Abstract

Forest resources in rural agrarian areas are often converted to cleared land for agricultural production. A high population density in the same area may shorten the fallow period and, through time, incorporate more forest land into agricultural production. Intensified land use systems in these highly populated areas have historically incorporated woody perennials in fields of staple crops to meet household demands of wood and non-wood products. These intensified land use systems are generally referred to as agroforestry systems and one example is dispersed tree agroforestry.

This research documented local indigenous knowledge regarding dispersed trees retained by farmers within their fields. Information was gathered using a survey questionnaire to guide informal conversations with resource-poor households in eastern El Salvador to assess: 1) tree species diversity and number of dispersed trees; and 2) the uses and management practices assigned to each species.

The study found that dispersed trees were selected on the basis of potential tree use and farmer experience because the wood and non-wood products and benefits were of greater value than staple crops. Multiple purpose tree species were retained by both renter and owner farmers because these species served as sources for tree fodder, fuelwood, shade, tool wood, and medicine. Tree fodder use during the dry season was a critical food source and maintained milk production within 5 % of wet season production rates. Twenty-seven tree species were critical for very specific one-time purposes such as corner-posts, rafters, and cross-beams used in house and out-building construction.

Key words: dispersed tree, agroforestry, indigenous knowledge, El Salvador, *Simarouba glauca, Mimosa tenuiflora, Guazuma ulmifolia, Cordia alliodora*

for

Ken and Karen Michmerhuizen

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Chapter 1

INTRODUCTION

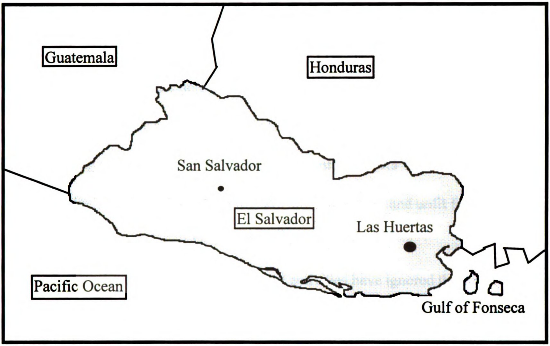
When asked which trees were left in the field as he was preparing it for planting that year, one farmer said, "Anything I like I leave." His sentiment is the assumption for the study because it focuses on farmer preference and uses of dispersed tree species in cultivated fields: farmers leave the trees they like. Another assumption is that dispersed trees on the agricultural landscape of heavily populated areas like El Salvador, are the necessary compromise of an agrarian society between food production and demand for wood and non-wood forest products. Presence of dispersed trees indicates that trees are an option for future opportunities and needs.

The goal of this research was to investigate the local knowledge regarding dispersed tree species in eastern El Salvador. The area was chosen because societies in agrarian areas of high population density have historically adopted intensified land-use systems that incorporate trees and shrubs to meet human needs (Raintree and Warner 1986). Studies to document farmer preferences of useful tree species have been done in areas such as Vanuatu (Barrance 1995), Ethiopia (Poschen 1986), Nepal (Fonzen and Oberholzer 1984), and Tamil Nadu, India (Jambulingham and Fernandes 1986). In each situation a farmer retained dispersed trees in cultivated fields because high population pressure had limited off-farm tree resources and increased the demand for tree products.

Land-use change in El Salvador has undergone several key events that shaped the patterns of present agricultural land-use. The Pipil and Lenca were early (ca. 900 A.D.)

settlers of the region that was to become El Salvador (Map 1) (Cardenal 1996). From former population centers, these early societies brought shifting, or slash-and-burn, agricultural practices. In this system a plot in the forest was cleared, the dry brush burned, and staple crops such as maize, beans, and squash were planted (Browning 1971). After several years the crop production level would diminish and another plot would be cleared. The fallow area would usually then regenerate: 1) a woody vegetation cover and 2) soil fertility through nutrient cycling of fallen leaf litter (Ewel 1986).

During the Colonial period, land-use in eastern El Salvador was primarily dedicated to commercial indigo and staple crop production through shifting cultivation methods (Browning 1971, Lindo-Fuentes 1990). The earliest historical reference indicates that the region of Las Huertas was brought into agricultural production by the mid-seventeenth century (Larde y Larín 1957). After the Colonial era, coffee plantation expansion in western El Salvador affected northern and eastern portions of the country through internal emigration of landless poor in search of settlement areas. Also, the population tripled during the 19^{th} century from 250,000 to 783,000 and tripled again over the next 60 years to 2,511,000 (Browning 1971). Coffee plantations were established on fertile volcanic slopes throughout the country, while the flat valley and coastal areas tended to support larger farms and cattle ranches. Modern agriculture inputs such as fertilizers, pesticides and new seed varieties have tended to concentrate on increasing export crop production of coffee, sugar cane, henequin, and cotton (Daugherty 1970). Under these historical events, the *entire* territory of El Salvador was populated by the early decades of this century and frontier areas ceased to exist. From the 1930's to the present, forest resources in El Salvador have been severely reduced and current



Map 1. El Salvador.

Map of El Salvador showing location of research site in Las Huertas.

estimates of forest cover range from 13 % to 14 % (2,800 km^2 to 3,000 km^2) of the national territory (Barry *et al.* 1996)[1]. A growing population has dramatically increased the need for staple crop production on farms which successive generations of rural farmers have continuously had to sub-divide (Barry *et al.* 1996). In 1971, 86 % of these small landholding farms (< 4 hectares) were concentrated on 19.5 % (283,311 hectares) of the total agricultural land in production and often located on land unfit for agriculture due to steep slopes and poor soil fertility (Diskin 1991).

Until recently, agricultural improvement activities have ignored the woody species component found within the farming system and concentrated instead on increasing the production of staple crops. Also, reforestation projects have tried to meet fuelwood needs through measures such as fuelwood plantations, yet ignored food production issues in communities they were meant to serve. Today, rural development projects seek to meet community needs through agroforestry improvements that provide services in areas such as marketable goods, domestic consumable products, and sustained agricultural yield through soil conservation and improvement (OAS 1994, Belaunde and Rivas 1993). A critical step towards project success is the investigation and incorporation of local knowledge regarding agricultural and natural resource use and the process of decision making which leads to resource use (Walker *et al.* 1995). Another author stated that, "the relative ignorance of the research community about woody plants used by rural people adds a special need for ethnobotanical research to identify promising species (woody and herbaceous) for agroforestry systems, and to understand what is

[1] Estimates of 3,000 km^2 include coffee plantations as forested areas.

already known about their interactions with soil, animals, other crops, and their uses, ownership and management" (Rocheleau 1987:71).

This study seeks to document the farmer knowledge base regarding dispersed trees that has allowed this traditional agroforestry system to become a part of rural life in El Salvador. The research objectives for this study were to: 1) develop a comprehensive description of the number and species diversity of dispersed trees, 2) describe the uses and products of dispersed trees, and 3) identify the persons (e.g. land renter, land owner, women, men) involved with the management of dispersed trees for the various uses and products.

Chapter 2

LITERATURE REVIEW

2.1 Site Characteristics

Natural Vegetation

The site, Caserío Las Huertas (N 13° 29'; W 87° 57'), is located 30 meters above sea level on hilly and eroded late Pliocene volcanic materials in the Tizate River valley on predominantly clayey Hapludalfs and Pelluserts, which may be shallow to bedrock (Daugherty 1970, Universidad de El Salvador 1974).

Holdridge characterized this zone as a tropical dry-forest, transitioning to sub-tropical dry forest. Bio-temperatures are ≤ 24 °C and air temperatures ≥ 24 °C for six months of the year (Ministerio de Agricultura y Ganadería 1978). Salvador Flores (1988) describes the same zone as a Lowland Deciduous forest community - *Selva Baja Caducifolia*. This vegetation pattern, the most widespread in El Salvador, includes the southern portion of the Department of La Unión and most of eastern El Salvador (Salvador Flores 1988).

Daugherty (1970) maintains that man-induced ecological changes began to occur in this area as shifting agriculture techniques favored and expanded pyrophytic taxa such as *Cresentia*, *Curatella*, and *Brysonima*. In El Salvador the result can be seen in present day savanna woodlands found in eastern San Miguel and La Union. These woodlands are named morro savannas, after the predominating morro tree (*Cresentia alata*). Some other woody plants associated with the morro savannas are commonly found in Caserio Las

Huertas (primarily in non-cultivated areas) and include tree species such as jícaro (*Cresentia cujete*), chapparo (*Curatell americana*), nance (*Brysonima crassifolia*), izcanal (*Acacia hindsii*) espino blanco (*A. farnesiana*), and carbón (*Mimosa tenuiflora*) (Castro 1978, Daugherty 1970).

Regional Climate

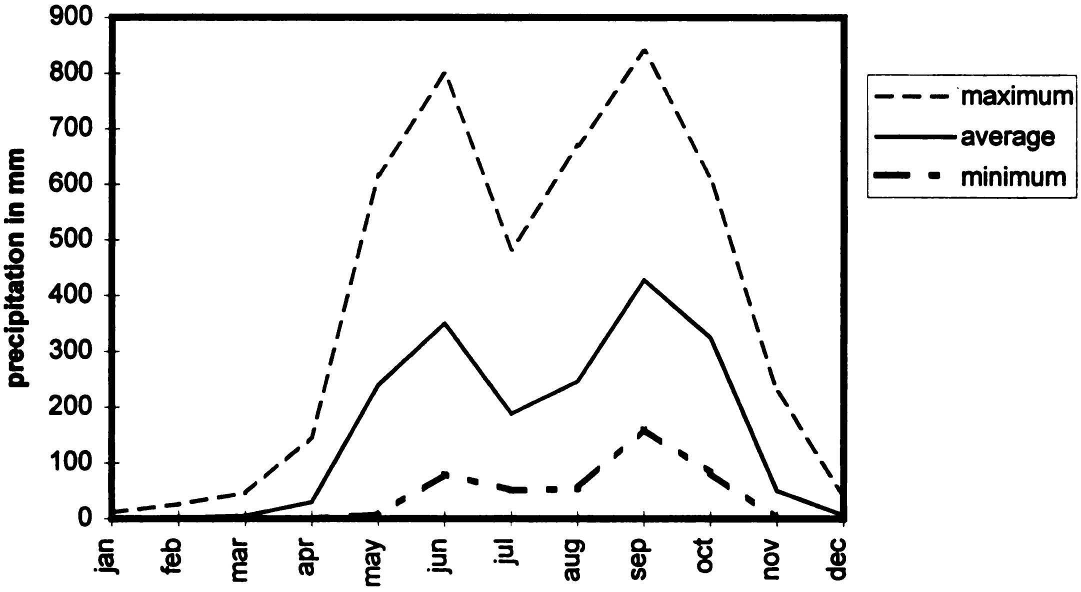
Köeppen describes the climate for eastern El Salvador as a tropical wet-and-dry climate (Vivó Escoto 1964). This designation signifies humid tropical climates where no month of the year has an average temperature less than 18 °C, and a distinct wet and dry season annually. The maximum precipitation is generally received in September and October (Vivó Escoto 1964).

The most influencing climatic factor of Las Huertas and the entire Pacific Coastal region of Central America are the distinct wet and dry seasons. This seasonality is due to the annual north/south movement of the Inter-tropical Convergence Zone (ITCZ) and the northern hemisphere subtropical high pressure cell (Daugherty 1970, Martyn 1992). Northeast Trade Winds, which dominate the wind patterns throughout the year, may carry moisture inland from the Caribbean Sea. However, this moisture is kept on the Atlantic facing slopes due to orographic precipitation, leaving most of Pacific Central America in a rain shadow for half the year (Vivó Escoto 1964). During the same period, the southern location of the ITCZ positions the northern hemisphere subtropical high pressure cell over Central America and the downward moving air associated with high pressure cells produces the dry season conditions from mid-November to May (Daugherty 1970).

Changes in climate begin when the ITCZ moves northward to about 12 °N, and the South Pacific High attains a northerly position bringing southwesterly winds that begin to carry moist air off the warm waters of the Pacific Equatorial Countercurrent (Vivó Escoto 1964, Martyn 1992). Rainfall during May and June is associated with two storm patterns. Initial showers, or "chubascos" are cloudbursts moderate in strength, which persist for 5 minutes to 2 hours, and may total >50 mm per event. These convection storms usually occur in late afternoon or early evening after a clear day of high afternoon temperatures , high humidity and sunshine. Towards late June, thunderstorms are occasionally moderate to strong in strength, with heavy steady rains lasting up to 8 hours, and may total 100 mm occasionally, and sometimes >150 mm (Instituto Geográfico Nacional 1979).

Following the early rains of May and June is a 30 - 40 day period of lesser rainfall, which is referred to as "canícula", or "veranillo" - little summer. This dry spell is related to the southward retreat of the ITCZ and an increase in atmospheric pressure (Vivó Escoto 1964, Daugherty 1970). The bimodality of precipitation in the Pacific Coastal region of Central America is clearly illustrated in Figure 1 (Instituto Geográfico Nacional 1979). Farmers in most of Central America and Mexico have responded to the annual occurrence of this dry spell by developing two planting seasons - early (primavera) and late (postrera). One farmer in the study stated "We like a good hot dry spell because the earth heats up and lets the seed of the late planting season grow strong. We usually have good harvests when the dry spell is hot and humid and poorer harvests when it just remains cool and humid".

Figure 1. Annual rainfall distribution for Cutuco, La Union, El Salavdor
(Instituto Geográfico Nacional 1979).



Distinct wet-dry season rainfall patterns are evident for this site 21 km. from Las Huertas.

"Canicula", or period of less rain fall due to southward retreat of the ITCZ.

Late rains begin in September and continue until mid-October, dropping off significantly in November. The showers of this period represent the majority of annual precipitation for this region and are characterized by two types of storms (Vivó Escoto 1964). One is a weak to moderate in strength local storm lasting 10 to 24 hours precipitating >150mm of rain. More common during this period is a low-pressure frontal storm, locally known as a "temporal". This storm is also weak to moderate in strength, yet lasts 24 to 72 hours with total precipitation between 100 - 600 mm, occasionally 800 - 1,000 mm (Instituto Geográfico Nacional 1979). Storms of the second variety frequently become stationed over the Gulf of Fonseca and contribute to the high September average rainfall of 400-500 mm for the surrounding area (Martyn 1992).

Lauer (1968) states that annual temperature variation in El Salvador is less than diurnal temperature variation. In San Salvador, which has data available for >50 years, the annual temperature fluctuation was calculated to be only 2.5 °C on average. However, average diurnal temperature fluctuations in dry months (e.g. January to April) were between 12 - 15 °C; whereas for humid months fluctuations were only specified as "somewhat less", but may average 6 °C in some years.

In Las Huertas and all of El Salvador, as the rains abate by mid-December, the winds steadily become northerly and high pressure dominates the region once again (Vivó Escoto 1964). December night temperatures reach 18 - 19 °C and are the coldest of the year in the coastal region, including Las Huertas (Ministerio de Agricultura y Ganadería 1975). In January, after the rains have ceased completely, it is typically cold and windy with a steady north wind blowing for days at a time. Rising diurnal and nocturnal temperatures typify February, but March and April are the hottest months of the year. In eastern El Salvador, including Las Huertas, the very dry, very hot clear days of April produce an average high temperature of 41 °C. Typically however, coastal day time temperatures are 28 -29 °C in April and May (Instituto Geográfico Nacional 1979).

Population and Settlement

La Unión is not as densely populated as other areas of the country. The land area of El Salvador is 20,935 km^2 and total population in 1994 was 5,641,000. Country-wide population density is 269.5 persons/ km^2. The Department of La Union is 2,074.34 km^2 and has a population of 255,565; yielding a population density of 123 persons/km^2 (Ministerio de Economia 1995).

The Municipality of San Alejo, which includes Caserío Las Huertas, is one of the least populated areas in the Department of La Unión. Rural population density for the San Alejo was 74 persons/km^2, which falls below the departmental average of 97 persons/km^2. Extending 251.64 km^2, the municipal population was 22,793 in 1992, which represents 8.9% of the total population of Department of La Union and 0.4% of the national population (Ministerio de Economia 1995). Irrespective of urban and rural population categories, San Alejo ranks 12th in population for the entire Department of La Unión and the average of 91 persons/km^2 (1992 Census) is below the departmental average of 129 persons/km^2. Thus, the population density of Las Huertas is not as high as areas such as Rwanda, Vanuatu, or Nepal.

2.2 Agroforestry

Agroforestry Description

Agroforestry practices are cultivation methods that incorporate selected woody species to accommodate such needs as fuelwood, building materials, fruit, fodder, and shade. Agroforestry has been described as:

> *...a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components* (Nair 1989:17).

These practices are manifested throughout the world and are not restricted to parameters such as population density, climatic conditions, economic development, or biogeography.

The biophysical interactions in agroforestry systems between tree and agricultural crop have been investigated to some degree and there is a growing body of scientific literature (Sanchez 1995). Investigations concerning agroforestry interactions have included: soil erosion (Lal 1989, Moench 1991, Dharmasema 1994, Banda *et al.* 1994); soil fertility, organic matter content, nutrient cycling, and microbial activity (Moench 1991, Haggar *et al.*1993, Campbell *et al.* 1994, Sharma *et al.* 1994, Nygren and Ramírez 1995); and root and canopy competition for light, water and nutrient resources (Kater *et al.* 1992, Kessler 1992, Ruhigwa *et al.* 1992, Schroth and Zech 1995). The results of these studies contribute scientific knowledge to the agroforestry research community and identify future research needs. Additionally the results can guide development project personnel as they plan agroforestry improvements with communities to increase positive and reduce negative biophysical interactions within the proposed intervention.

Dispersed Trees

Agrarian areas of high population density and reduced land-holdings require intensified agroforestry systems and woody species have often been integrated into these systems as live fences or dispersed trees (Raintree and Warner 1986). Dispersed trees are those which have been deliberately retained or planted within a cultivated area by the farmer. They are left during clearing or field preparation to provide some benefit or function that takes precedence over annual or perennial crop production.

There is a growing body of scientific information regarding the retention of trees in dispersed patterns across agricultural landscapes. The following section provides geographical location, tree species names and information concerning dispersed trees in studies of nutrient cycling and soil condition/fertility (Jambuligngam and Fernandes 1986, Poschen 1986, Altieri *et al.* 1987, Jofre *et al.* 1988, Vityakon *et al.*1988, Ulluwishewa 1991, Kater *et al.* 1992, Kessler 1992, Sae-lee *et al.* 1992, Jodha 1995), grain/pasture yields and climate modification (Poschen 1986, Jofre *et al.* 1988, Akbar *et al.* 1990, Kessler 1992, Sae-lee *et al.* 1992, Sharma 1992, Dove 1995, Jodha 1995, Tilander *et al.* 1995), and tree uses and functions (Geilen 1982, Fonzen and Oberholzer 1984, Jambuligngam and Fernandes 1986, Shankarnarayan *et al.* 1989, Jofre *et al.* 1988, Wapakala 1988, Ulluwishewa 1991, Erkkilä and Siiskonen 1992, Kater *et al.* 1992, Kessler 1992, Khaleque and Gold 1993, Kimwe 1993, den Biggelar and Gold 1996, Barrance 1995, Dove 1995, Jodha 1995, and Scherr 1995).

Numerous multiple purpose trees (MPTs) are retained as dispersed trees in Tamil Nadu, India (Jambulignggam and Fernandes 1986). For example, palmyrah palm (*Borassus flabellifer* (L.)) is primarily used to provide a sugary exudate called *nera*, which is collected during the dry season when there is less annual crop work in the field. Kapok trees (*Ceiba pentandra* (L.)), typically planted around the field boundaries and roadsides, are harvested for the flossy fibers from the seed endocarp (Jambulignggam and Fernandes 1986). Jodha (1995) and Shankarnarayan *et al.* (1989) state that khejri (*Prosopis cineraria*) and ber (*Ziziphus numalaria*) are both maintained within fields for fodder and fuel. Dove (1995) reports that in northwest Pakistan, 74 % of the households surveyed left trees on the farm landscape either singly or in small numbers for fuelwood, timber and fodder.

Fonzen and Oberholzer (1984) reported that MPTs in western Nepal are preserved/retained on a terrace when it is established. Apart from the uses provided by the trees (fodder, fuel, fruit, fence and timber), tree retention on the terrace allows for farming to continue on the 40 -70 % slopes in that region. Khaleque and Gold (1993) reported that Garo farmers in Bangladesh developed a pineapple agroforestry system in response to changes land use rights and population pressure. On the island of Mota Lava in Vanuatu, as garden size decreased, important fruit trees were planted in taro gardens and along property boundaries with other perennials (Barrance 1995). Variations of the same taro garden farming system were employed on Paama, where rerau (*Trema orientalis*) trees were allowed to regenerate as fallow vegetation in the taro gardens at higher altitudes. These slender stems, cut back during preparation, were used as fencing material for the growing cycle and removed for fuelwood after the taro harvest (Barrance 1995).

Investigations of retained tree practices on rice paddy fields or bunds in Thailand reveal farmer awareness of the soil enriching capabilities of the retained trees. Sae-lee *et al*. (1992) state that *Samanea saman*, *Parinarim anamense*, *Dipterocarpus obtusifolius*, and *D. intricatus* were all retained or planted on rice paddy bunds to positively effect soil fertility. Ulluwishewa (1991) documented the traditional rice cultivation cycle and mentioned that trees were left to provide shade for meal times when working in fields.

Jofre *et al*. (1988) describe the present state of the oak parkland "dehesa" agroforestry system of southern Spain. Although the sustainability of this system has been dramatically reduced in the last 40 years, it still provides crop land, fruits for foraging domestic animals, shade, tannins, and cork.

Dispersed tree agroforestry experiences in Kenya have been documented by several authors (Geilen 1982, Wapakala 1988, Castro 1991, Kimwe 1993, and Scherr 1995). Dispersed trees are typically sources of building poles, fuelwood, and fruit (Wapakala 1988, Kimwe 1993, Scherr 1995). Gielen (1982) documented 24 indigenous trees used for non-fruit products and 11 fruit producing trees all grown within cultivated fields. Castro (1991) provided a historical perspective on the development of agroforestry systems leading up to the present in areas near Mt. Kenya.

In Sahelian west Africa, sorghum is planted in association with *Vitellaria parodoxa* and *Parkia biglobosa* that are retained as food sources and for shade (Kater *et al*. 1992, Kessler 1992,). *Vitellaria parodoxa* fruits are a source of fat after being processed into butter and *Parkia biglobosa* is used for the sugar extract to make "soumbala" vegetable cheese, medicine and timber. Meihe (1986) reported findings from a study from western Sudan that included *Faidhadia albida*, *Cordia abyssinica*, and *Ziziphus spina-christi*. Dispersed within the fields of sorghum and millet, these trees provided seasonal fodder (e.g., pods and leaves) for grazing animals. Particularly important was *F. albida* that is leafless during the planting season and foliates during the dry season. Similar benefits are described by Poschen (1986) in an evaluation of the *F. albida* agroforestry system in eastern Ethiopia. Rwandan farmers leave woody plants, but also include leaving herbaceous materials in their fields that they classify as "trees" or "shrubs" (den Biggelar and Gold 1996).

Erkkilä and Siiskonen (1992) described traditional uses of tree species in Namibia. For example, the fruits of marula (*Sclerocarypa birrea* subsp. *caffra)* are commonly used to make wine and the trees are retained with mahangu millet (*Pennisetum glaucum*) cultivation in Owambo. Also, mopane (*Colophospermum mopane*) is extensively used in the construction of homestead palisades and walls in the same region of the country.

The presence of trees in cultivated fields in Latin America has been documented by several authors and identified as a potential solution to present-day farmer needs (Muñoz Aldeán 1981, Altieri *et al.* 1987, Morrison 1991, Belaunde and Rivas 1993, Torres *et al.* 1993, Radulovich *et al.*1994).

Torres *et al.* (1993) reported that nineteen trees/shrubs were identified as useful by residents in the Altiplano of Peru. Andreatta (1994) reported that Jamaican farmers planted eleven species of fruit bearing trees in their fields. Several papers mentioned the retention of useful trees within pastures (Morrison 1991, Muñoz Aldeán 1981). Yerba mate (*Ilex paraguariensis*), is known by the author to be cultivated as a dispersed tree in Colonia Katuete, Paraguay. Muñoz Aldeán (1981) states that trees in some regions of the Ecuadorian Andes are often left to grow around fields more than within them, forming property delineating boundaries.

Recently, several agroforestry projects in Central America and the Caribbean have established or recommended dispersed tree plantings in cultivated fields. Morrison (1991) recommends that Jamaican farmers plant preferred fodder trees within crop lands to augment dry-season fodder shortages. The Plan Trifinio fuelwood reforestation project expanded beyond initial community fuelwood plantations to incorporate fruit tree demonstration plots at the request of numerous beneficiaries (Organization of American States 1994). Farmers involved in the Madeleña 3 project expressed interest to plant *Eucalyptus* spp. within their maize fields (Belaunde and Rivas 1993). Juárez and McKenzie (1991) completed a financial analysis for this system that projected higher four-year returns for a maize and *E. camaldulensis* intercropping, than either sole maize or pure tree plantation.

The citations above provide clear evidence that the retention of dispersed trees on agricultural landscapes commonly occurs in areas of high population, decreased field size, and reduced forest resources. Farmers in eastern El Salvador also appear to retain dispersed trees on the agricultural landscape and this study will attempt to document whether this is a planned activity or an artifact of the farming method. No literature was noted which described this approach for farmers in El Salvador.

Tree/Crop and Soil Interactions

Soil properties are often modified through the addition of organic matter to the soil and these complex biophysical relationships have received attention from many researchers. In general, research indicates that soil organic matter and nutrient levels increase in close proximity to a tree canopy.

Decreased nutrient levels for soil nitrogen, phosphorus, and calcium, along with cation exchange capacity, were reported with increased distance from dispersed trees in maize-*Prunus* spp. traditional agroforestry plots in Tlaxcala, México (Altieri *et al.* 1987). The authors suggested that the tree canopy provided additional organic material through leaf litter fall that contributed to soil conditions. A study of soil fertility and hydrological balance under a dispersed tree canopy found that "the value for organic content, total exchange capacity, potassium, phosphorus, total nitrogen and carbon contents are twice those of the same variables outside the tree canopy cover" (Jofre *et al.* 1988). These results were reported at the 0-5cm depth, the most biologically active soil region, and at the 5-20cm depth. The improved soil conditions were attributed to leaf shedding, litter fall, and excretions from grazing animals (Jofre *et al.* 1988). Poschen (1986), in a study in eastern Ethiopia, reported a 56 % increase in crop production under the canopy of *Faihidia albida* due partially to increased organic matter and soil moisture content under the canopy.

Studies of fine leaf decomposition on rice paddy bunds or in fields have also been shown to be related to increased soil organic matter, fertility, and cation exchange capacity (Vitayon *et al.* 1988, Ulluwishewa 1991, Sae-lee *et al.* 1992). Soil fertility measurements (organic matter, nutrient content, and pH) taken under *Samanea saman* tree canopies showed a higher nutrient content and lower C/N ratio than soil samples not affected by any tree canopies and increases were shown to be highest at positions nearest the tree itself (Sae-lee *et al.* 1992). Kessler (1992) reported however, that soil fertility did not vary under the tree canopy or the open field. Another study in the same region did report that the soil directly under the tree was positively affected by the additional organic matter (Kater *et al.* 1992). In one case, increased humidity (in soil and air) under the tree canopy reduced the number of plants that could survive. It was assumed that fungi thrived in this environment and damaged the plants (Kater *et al.* 1992).

This brief review provides evidence that positive changes in soil nutrient levels, organic matter content and cation exchange capacity are possible when leaf litter is added to the soil. In each case, leaf litter was provided by dispersed trees and impacts decreased with distance from the source. Although dispersed tree and soil interactions were not researched in the study area, this researcher was looking for awareness on the part of farmers about any perceived soil improving properties of dispersed trees.

Tree/Crop and Light Interactions

Trees have often been planted in rows as windbreaks designed to reduce soil loss caused by wind erosion. However, researchers have been concerned regarding the reduction of photosynthetic active radiation (PAR) on crops grown under the influence of tree canopies (Brewbaker 1987). The reduction in photosynthetic rates of food crops growing in the shade of a dense tree canopy may affect the overall growth of the plant and grain production. Decreased crop yields may especially be found in C4 crops such as maize and sorghum, which typically have high photosynthetic rates (Salisbury and Ross

1985, Kessler 1992, Kater *et al.* 1992). Likewise, reductions in C3 crops, such as wheat and beans have also been reported (Akbar *et al.* 1990, Sharma 1992, Chirko *et al.* 1996).

Kessler (1992) and Kater *et al.* (1992) reported sorghum yield decreases of 50 to 70 % under tree canopies of *Vitellaria parodoxa* and *Parkia biglobosa.* Tilander *et al.* (1995) completed a follow-up study in the same area and reported that sorghum grain yields under trees coppiced (i.e. reduced canopies) were 48 % higher than trees not coppiced. These results indicate that reduced canopy shade and increased soil fertility through organic matter accumulation appear to have created optimum growing conditions for crop plants. Also, Tilander *et al.* (1995) reported that plants around trees coppiced early produced higher yields than if coppicing was done later in the growing season and may indicate that initial growth is affected by shading.

Chirko *et al.* (1996) reported on direction and distance effect of variations of light intensity on a *Paulownia* tree and wheat crop planting system in northern China. *Paulownia*, a tree native to China, demonstrates late leaf emergence and thereby favors the planting of a cereal crop, such as wheat, because the tree does not shade the growing crop until later in the spring season. Wheat grain yield and kernel weight did not differ on either side of the north-south planted *Paulownia* row. However, grain yields did show differences when under tree yields were compared to yields 20m away from the rows of trees.

Sharma (1992) studied *Acacia nilotica* var. *jaquemontii* field bund tree and wheat crop interactions in north Central India. Decreased grain yields nearest the field bund were attributed to shading. It was recommended that pruning could reduce this affect, especially at the <4m range where yield decrease was greatest. Akbar *et al.* (1990)

investigated boundary tree (*Eucalyptus camaldulensis*, *Albizia procera*, *Morus alba*, and *Leucaena leucocephala*) and wheat crop interactions planted under rain-fed conditions in Pakistan. In all cases wheat yields were lowest at <2m on either side of the north-south tree lines and increased with greater distance from the tree line, until "there is little, if any, impact up to 6m distance and almost no impact at 8, 10 , or 12m distances" (Akbar *et al.* 1990:8).

The importance of tree-crop light interaction research cannot be overemphasized. In the context of this study, tree and crop interactions are significant because farmers often prune tree branches to minimize the shading affects of dispersed trees. These management activities to minimize crop loss due to shading, must also respond to the social context of land tenancy and access rights within which the farming operation functions.

2.3 Land and Tree Tenure

Land and tree tenure systems in agricultural societies define resources, users, management, and inheritors of trees and land alike. Tree and land tenure has often been viewed collectively; however, it is critical to consider them as independent yet linked, because "many agricultural peoples differentiate rights to plants from rights to the land on which they are growing" (Weinstock and Vergara 1987). Numerous concepts and degrees of tenure and access to resources exist within any given community. Often access is *de jure* ownership by law, *de facto* ownership by use, or *usufruct* which is the right of a user to use and enjoy a piece of property as though it were private, yet without destroying the item (Fortmann 1992). Also, tenure or usufruct to land or trees may be inherited through a maternal or paternal lineage (Castro 1991) or may acquired through purchase (Cernea 1981)

Understanding local tree and land tenure is critical in agroforestry because it may place limitations on tree planting opportunities or influence tree survival. Often the incentive to plant and care for trees are low if insecurities surrounding land tenure issues exists for a community of user group (Khaleque and Gold 1993). Tree planting may secure tenure, as in the case of Indonesian farmers who planted rattan to secure *de facto* ownership because tenure was insecure for unplanted areas (Weinstock and Vergara 1987). Clear understanding of local tenure practices is critical for any type of improvement project designed to apply benefits to all sectors of the population. Cernea (1981) reports that misinterpretation of tenure status for land to be reforested would have benefited only those people who actually had access to the forest area. Access and tenure status is gender influenced as well and can lead to either opportunities for both women and men or limitations for one group and advantages for the other. Rocheleau (1985) reports that tenure laws were often cast in favor of men in Africa during and after colonial rule. Presently, these differences define where and what can be planted and harvested for women in many societies. Land and tree tenure issues can also be viewed according to user groups. Rocheleau (1987) defined several groups and those which apply to this study could be defined by activity (large or small farmers), by rights of access and ownership (individual *de jure* owners, renters, users by permission), and by management unit (individuals [men, women, children], households, and communities).

Local farmer uses and management activities documented in this study rests within the complex land and tree tenure systems of El Salvador. Gathering information about the interactions between user groups allows a concept of how tenure influences management decisions and activities.

2.4 Gender in Agroforestry

Gender division does not, in many societies, provide an equal division of either the resources, responsibilities, or corresponding benefits of the resource among men and women. Agroforestry systems are also affected by gender divisions of whose plants are whose, who will take care of which plants, and who had access to what (Rocheleau 1985). Labor issues can also be tied to tenure issues. For example, extension efforts in Nigeria with an alley cropping soil enrichment system met with little success. In the local culture of the project region, women were discouraged from tree planting because men feared diminished tenure status on fields with trees planted by women. To circumvent the issue, extension agents called the tree a bush (Cashman 1988). Preferred tree species are often distinct between men and women as well. Hocking *et al.* (1996) reported results from a Bangladesh tree planting campaign in which women chose to plant more fruit bearing and fuelwood species within the homestead and men chose to plant more valuable timber trees in fields.

2.5 Indigenous Knowledge

Using Indigenous Knowledge in the Development Process

An author recently wrote that if participation is the key to project success and accuracy, then indigenous knowledge (IK) is the key to participation (Havercort 1991). Until recently, development and agricultural improvement projects have typically side-stepped indigenous knowledge in favor of the "scientific" approach. This approach often undermined the dignity of local people the project was meant to serve. Frequently in these "top-down" approaches the beneficiaries were not contacted as to what they desired, what they knew, and were generally left out of the planning process (Mathias-Mundy 1993). In these circumstances, project failure around the globe was frequently attributed to many things such as lack of education, lack of resources, or lack of sophisticated methods "designed" to function with maximum efficiency, but rarely to poor planning or implementation.

Since the early 1980's however, there has been a growing awareness that greater participation at the initial stages of project development can foster pride and project ownership among participants and that "success" can be achieved through more "bottom-up" projects (Bunch 1982, Walker *et al.* 1995). Over the last 15 years, several new understandings of development have become apparent. First, it has been recognized that people-focused projects at a smaller, more manageable scale are better able to respond to changes in project direction (Bunch 1982). Second, although the long-term goal may be healthier living or food security, the pathway toward that goal must necessarily pass through people-development (Bunch 1982). And third, indigenous knowledge is a component of the people-development process because it "reflects the dignity of the local community and puts them on equal footing with the outsiders involved in the process of technology development" (Havercort 1991).

A further step toward indigenous knowledge utilization and community participation arises when farmers become experimenters with agricultural technology on their own land (Havercort 1991). Research station experimental conditions are typically strongly controlled using outside chemical inputs and machinery. Replication of yield results depend on precise management guidelines for the farmers to follow. This typically results in little to no adoption by resource limited farmers. To avoid transfer problems project personnel with Madeleña 3 pre-selected demonstration farms that were representative of the local farming systems surrounding the proposed farm (Reiche 1988). Later, farmers involved in the project participated as the main experimenters after they expressed interest in intercropping maize-*Eucalyptus* spp. plots (Belaunde and Rivas 1993). A tree planting campaign in Bangladesh also relied on farmer-management for project implementation (Hocking and Islam 1995, Hocking *et al.* 1996). This project allowed farmers to assume the responsibility for the care and benefit of as many trees as they desired to retain on their land. In the initial stages farmers were given tree seedlings and basic planting advice and then were allowed to manage the trees. After the third year, farmers had removed poorly grown and unwanted dispersed trees. Stocking rates within fields after six years were approximately 55 % of the original designed stocking rate of 120 trees/hectare, with the majority of mortality attributable to livestock browsing (Hocking and Islam 1995, Hocking *et al.* 1996).

Literature provides strong indicators that project success is directly linked to community based contributions, direction, ownership and management. This study was completed with the anticipation that non-governmental or governmental agencies involved with agroforestry projects in El Salvador would use this information to engage rural communities designing projects that address local needs.

Indigenous Agroforestry Knowledge

Research has been done regarding indigenous agroforestry in many parts of the world. Many farmers in Central America use certain tree species as live fence posts and secondary products and 92 tree species were recorded in one study (Sauer 1979, Budowski and Russo 1993). An investigation into Rwandan farmer indigenous knowledge and plant classification systems regarding the woody and non-woody material in their fields revealed that farmers had deliberately located each tree found in the fields (den Biggelar and Gold 1996). Indigenous knowledge concerning traditional forage and fodder plants has been done in Nigeria (Bayer 1990), Jamaica (Morrison 1991), and Nepal (Rusten and Gold 1991).

Indigenous knowledge has also been used to establish or guide agroforestry improvement projects. Vabi (1996) describes how participatory research methods used in a inter-agency agroforestry project in Cameroon and the Central African Republic resulted in appropriate species selections for the beneficiaries. A plantation forestry program in Vanuatu was suspended once project personnel realized that local villagers would obtain little benefit from the project (Barrance 1995). Foresters then spoke with villagers and redirected the project to include local village agroforestry practices which provided appropriate benefits.

Indigenous technical knowledge is very closely associated with the use or function of the preferred trees or shrubs in an agroforestry system. Farmer families in Mangwende, Zimbabwe traditionally intercrop mango trees and staple crops in communal areas (Musvoto and Campbell 1995). Results indicated that farmers prune branches to provide optimum yields of fruit and staple crops and then use the branches for fuelwood, poles, posts, or construction. Farmers in Burkina Faso also prune tree branches to maximize fruit harvests, yet consider fuelwood and better crop growing conditions as incidental to preserving tree health and productivity (Timmer *et al.* 1996).

Literature sources provide ample evidence that traditional knowledge of agroforestry systems is complex, varied, and cosmopolitan. Concurrent with this nascent appreciation is the need to incorporate indigenous and scientific knowledge within project development. However, "before this indigenous technical knowledge can be successfully used for development, information on it must be collected , documented and evaluated" (Mathais-Mundy *et al.* 1992:2). This research has been completed to provide some initial documentation of indigenous agroforestry practices of dispersed trees for El Salvador.

Several authors recently reported that ecological knowledge is the basis for indigenous agroforestry knowledge and therefore ultimately the source for farmer decision making (Walker *et al.* 1995, Thapa *et al.* 1995). Ecological knowledge therefore, guides and directs farmers' decisions and perceptions concerning the interactions that occur between crops and trees. By understanding these concepts agroforestry researchers have opportunities to identify areas where traditional knowledge and scientific knowledge correspond or complement each other, and which areas could be further investigated in cooperation through on-farm research (Havercort 1991, Walker *et al.* 1995, Thapa *et al.* 1995). There are examples of this idea which illustrate the concept quite well. For example, stated that Nepalese farmers understand the influence of "shade and splash erosion caused by leaf droplets (a process locally referred to as 'tapkan') reduced crop yield, and that tree attributes such as leaf size, leaf texture, crown density, crown size, tree height, and leaf inclination angle influenced shade and/or leaf drip effects" (Thapa *et al.* 1995:252). Paraguayan farmers also identified certain plants that were *caliente* ("hot") and warned against planting crops in close proximity to them. Ignorance of these concepts could reduce acceptance of agricultural "improvements" and

Walker *et al.* (1995) recommended that traditional ecological knowledge and empirical scientific knowledge be engaged in the development process with local communities to compliment areas where scientific knowledge is missing key ecological concepts.

2.6 Survey Methods

Interviewing

Research information is commonly gathered through an interview process, of which there are many variations (Derman 1990). Often, if there is a particular resource user group within a population, a focus group approach may be used to acquire inputs from various people. Sensitive topics typically require a certain level of privacy and confidentiality and for this reason the participants in these studies are often interviewed alone. Conducting survey research in developing countries often requires added attention and awareness by the interviewer regarding cross-cultural issues (Buzzard 1990). The most difficult issues arise when multiple languages are used since answers may contain nuances and subtleties of language that can be lost in translation and therefore rendered useless if taken literally (Derman 1990). Also, there are certain customs and practices regarding gender associations which may restrict the ability of a researcher to meet and survey certain participants (Buzzard 1990). The amount of time an interview will require also needs to be addressed by the researcher. Improper time demands can cause many problems, for example, a long interview may cause a respondent to answer quickly in a rush to finish the interview and with opinions that may not be truly representative (Buzzard 1990). Failure to address these cultural issues places limits on the research gathering process and applicability of study results (Buzzard 1990).

To achieve accurate information an interview must be a relaxed open interaction between researcher and subject and rapport must be established with each individual respondent during the interview. If a series of questions flows in logical order, an interview can have a relaxed atmosphere where the researcher guides the respondent (Burgess 1991). During the interview process, the researcher is encouraged to listen more than talk, not interrupt, and perhaps rephrase or reflect out loud the topics that were just discussed. By repeating information the respondent may hear what was understood by the interviewer, correct the information if needed, and allow a more precise recording of the information (Whyte 1991).

Survey Instrument And Sample Population

Information gathered during an interview is typically noted on a survey form or recorded using a tape player. A coded survey form is often used because coded questions reduce the amount of interruptions during the interview caused by paper shuffling and searching for the next questions. Coded forms therefore allow the researcher to accurately formulate the next question and record the answer, which in turn allows the questions to flow in an even manner and become an informal conversation (Burgess 1991). To facilitate post-interview information verification, researchers often tape record an interview to be replayed later (Kumar 1989). However, tape recording an interview in a cross-cultural setting may arouse suspicions among respondents as to the real intent of the interviewer (Morrison 1991). The number of questions should be limited to only those which will add pertinent information to the study; however, if certain individuals are able and willing to provide more information they should not be discouraged (Burgess 1991).

A sample population is chosen because it reflects the characteristics of the larger population. If there is a great amount of diversity in a population for social characteristics such as religion, ethnicity, language, or birthplace then a larger sample of the population must be taken to ensure greater representation of the various groups (Buzzard 1990). Likewise, surveys conducted in areas with a homogeneous population regarding these issues may not require a sample population of more than 40 - 50 households (Aleck and Settle 1985). Involving a respondent in an interview must be done on a strictly voluntary basis and giving gifts or paying people to cooperate is generally not recommended (Buzzard 1990).

The interview and survey techniques cited above were used to guide this research during preparation, surveying and data compilation. Open rapport and willingness to communicate with any party concerning any question was a priority during the study and measures were taken to minimize logistical problems and peoples' suspicions of the research process.

Key Informant Interviewing

Throughout the duration of the research period the researcher was able to gather additional information, though simple observation of every day activities, about tree product uses and management in the study area. Key informants were consulted to better understand the observed phenomena. Kumar stated that, "key informant interviews involve interviewing a select group of individuals who are likely to provide needed information, ideas, and insights on a particular subject"(Kumar 1989:1). This group need be only a few knowledgeable individuals drawn from the sample population who are interviewed more intensively and for an extended period of time (Kumar 1989, Tremblay 1991).

Soliciting information from key informants has certain advantages and disadvantages. Advantages include the acquisition of broader information concerning difficult or time consuming explanations from a few knowledgeable persons. Also, new information may be provided which can guide the development or procedure of regular surveys. Certain disadvantages also exist which include bias due to wealth or employment. Interviewers can also obtain biases early on concerning a topic and then 'listen for' that subject to confirm pre-conceived ideas (Kumar 1989, Tremblay 1991).

Typically informants in this study were long-time residents, respected by others in the community, deemed knowledge by others regarding tree uses, and willing and able to communicate their knowledge. Key informants were consulted during the research period for in-depth conversation concerning: activities involving wood products, tree species descriptions and management, and gender roles concerning tree use and management. Selection of these informants usually occurred after the regular interview had taken place and rapport had been established.

2.7 Woody Species Taxonomy and Descriptions

The principal sources for scientific nomenclature and descriptions for this study came from three sources specific to El Salvador. Calderon and Standley wrote Lista Preliminar de Plantas de El Salvador (1941) which is a later edition of their earlier work (1925). Felix Choussy produced a four volume set Flora Salvadoreña (1976) which includes photographs of the species and a very brief species description. Witsberger, Current, and Archer wrote Arboles del Parque Deininger (1982) which includes illustrations, lengthy descriptions, and bibliographic information for the tree species found within Deininger National Park.

Cross-referencing materials for botanical names included several sources from the Caribbean, the Meso-america, and South America. Very helpful was Common Trees of Puerto Rico and the Virgin Islands, Vol. 1 (Little, Jr. and Wadsworth 1964) and Trees of Puerto Rico and the Virgin Islands, Vol. 2 (Little, Jr. *et al.* 1974). Nomenclature Polyglotte des Plantes Haitiennes et Tropicales (Pierre-Noel 1971) served as an excellent tool for common names for most of the Americas. Practical information regarding the silviculture of many tropical species was provided in El Arbol, Vol. 2 (Geilfus 1994). A dry-tropics Meso-american source was Principales Arboles del Alto Balsas (Guizar Nolazco and Sanchez-Velez 1991). Lopez produced Arboles Comunes del Paraguay (1987) a text quite similar to Arboles del Parque Deininger. Other reference materials consulted covered ethnobotany (Fowler 1989) and species descriptions for certain Leguminosae (Allen and Allen 1981).

Chapter 3

MATERIALS AND METHODS

3.1 Materials

Site Selection and Sample Population

The survey was conducted in Caserío Las Huertas, Cantón El Tizate, Municipality of San Alejo, Department of La Union, El Salvador (N 13° 29'; W 87° 57'). This area of the country was chosen because of the semi-arid climate and tropical-dry deciduous vegetation. The specific site was selected in cooperation with personnel from Peace Corps-El Salvador and the Center for Tropical Agronomy Teaching and Research-El Salvador (CATIE). This region of El Salvador was also chosen because the climate and vegetation characteristics are shared with the Gulf of Fonseca coastal areas in Honduras and Nicaragua.

As one takes any road or path into Las Huertas it is impossible to miss the large flat-topped hill (Cerro La Picachos) which dominates the view. In the valley lies the Tizate River winding its way towards the Gulf of Fonseca. On the valley floor and hill sides is a patchwork of farm plots. Steep slopes, rock outcrops, and riparian areas are forested and remain outside of the agricultural spectrum. Fallow ground and pastures are covered in a thorny shrub vegetation dominated by *Mimosa* spp.

The community of Las Huertas was specifically chosen for several reasons. First, the rural population of the area is homogeneous regarding language, religion, and ethnicity. Second, agricultural practices in the wider research area are similar to those in

Las Huertas given the climate patterns and ecology of the entire region. For these reasons, and mobility and time constraints, the survey efforts were focused exclusively on the resident of this community. Through the course of the study all households in Las Huertas were invited to participate. Because the entire community was interviewed the surveyed population represents a census and not a selected sample. Of the 43 households consulted for the study, 38 were actively farming during the 1996 farming season. These 38 farmers were further consulted regarding each dispersed tree species growing in the field(s) they were cultivating or planned to be cultivating that farming season. Nineteen farmers had bovine animals and were asked another set of questions pertaining to management and milk production of these animals.

Survey Instrument

A questionnaire was created to facilitate the collection of pertinent information related to household and farming systems such as farm size, cropping patterns, and livestock in a guided, yet informal interview process (Appendix G). The questionnaire consisted of several sets of questions, not all of which were discussed with every respondent. Certain sections such as cattle ownership, tree fodder usage, or dairy cow milking only applied to households that engaged in these activities.

Tree measurements (diameter-at-breast-height, crown diameter, and height) were recorded for some of the dispersed tree species. Due to time constraints, tree size measurements were not collected for all trees or species.

3.2 Methods

The person within each household primarily responsible for the clearing, preparation, sowing, care and harvest of staple crops was interviewed in this study. It was assumed that this person would have the most interaction with the retention, management and use of dispersed trees. Divisions of labor exist among many rural farm families in El Salvador, including La Huertas (Marroquín 1980). In Las Huertas, men were engaged in field crop production and women primarily with household duties and care of children. This is certainly not the situation in every rural area of Central America or even El Salvador (Safa 1992). This definition resulted in a large number of male respondents as compared to female respondents. However, over half of the male respondents were joined by their wife during the interview process and actively participated. Based on the survey respondents, inferences or analyses were not considered along gender divisions.

Interview Process

The interview process consisted of usually three, sometimes two, visits to each household. The initial visit was to introduce the researcher, establish a rapport, socialize, and answer any questions that members of the household might have concerning the survey or other topics. All interviews were conducted in Spanish and a translator was not used.

During this first visit, a time was determined when it would be convenient to return to complete the first section of the survey. This portion was completed for all households, often during the first visit. The interview process was a relaxed informal conversation guided by the researcher which allowed the farmer to respond at length. Information was recorded on the questionnaire during the interview and answer time was not limited.

Field Informal Interview

If a farmer indicated that the family was farming that year, a visit to the fields under cultivation was scheduled. Typically, this would occur within the next day or two. In the field, farmers were consulted regarding every dispersed tree species growing within each plot they were farming that year. Farmers frequently have knowledge of many uses for a particular tree species, however a particular use may stand out during an interview depending upon current need. For this reason farmers were asked to prioritize the uses of the trees available to them in order that importance could be determined independent of immediate need. The information recorded included: name of the tree, uses of the tree, which part of the tree was used for specific purposes (bark, leaves, branches, trunk, etc.), when was the tree used for this specific purpose, how was the part physically obtained for the specific purpose (i.e. are the branches removed, are the fruits collected, is the tree removed, etc.), who utilized the tree for the specified purpose, was accessibility to use influenced by land tenure, and who planted the tree. Total number of individual trees was recorded by species, within each field.

Whether a person has usufruct or tenure to a particular resource may influence the opinion of that person regarding the usefulness of that item to that person. Because tree ownership is implied through land ownership in the study region, owner farmers were not asked questions regarding tenure and access was assumed. However, to examine tree tenure for rented land, each renter farmer was asked if access to the particular use(s) described were prohibited or not. If a person replied that a use was restricted, they were asked if restrictions were always applied to that use. If they replied negatively they were then asked to describe when and under what conditions they were able to access the resource for that use.

Questions about each tree species were answered while visiting each field. Individuals of the same tree species were not examined more than once in the same field. However, at least one individual was examined in each new field. Tree size measurements were taken for roughly 10 % of all dispersed trees in the study area. Diameter at breast height (dbh) measurements were taken using a dbh tape. Height measurements were taken using a clinometer. Crown diameter estimates were taken by averaging the total of four distance measurements from the trunk to the edge of the crown in different directions.

Key Informants

Key informants were consulted during the survey to clarify or broaden knowledge concerning observed activities involving wood and non-wood forest products. Throughout the three month stay in the area, the researcher was a participant in many of the daily and several extraordinary social events (e.g. socializing, collecting water at the spring, patron saint festival). During these events wood products of various tree species were often used and the researcher would ask a few probing questions to explore the persons knowledge of the item or activity. Later, several key informants would be asked to elaborate upon the activity or item used to obtain a greater perspective of wood use.

An advantage of working with informants is that encounters were informal, not time demanding, and usually took place in afternoon hours. Two key informants most frequently encountered in the study area were landlords of the researchers' domicile and visited everyday. All the people consulted as key informants were considered by other residents as knowledgeable and reliable sources. Certain disadvantages of working with informants centered on the researchers biases through time. It was essential that the researcher did not begin to listen for certain uses or species and ignore those references which contradicted previously recorded information.

Data Handling and Statistical Methods

The researcher was the only interviewer during the entire research process. Surveys and accompanying notes were reviewed, checked for accuracy and coded at the end of each field day. Categories of data collected included both quantitative (e.g. number of hectares, number of trees) and qualitative (e.g. first, second, and third use of a dispersed tree). Additionally, nominal data was gathered for each tree (name) and field (e.g. rented or owned, maize-sorghum, maize, sorghum). Comparison of means test were done using an independent samples t-test for equality of means. Frequency data comparisons and cross-tabulations were utilized to interpret the qualitative survey results. Pearson correlation analysis was used to assess the linear association between quantitative variables and test the statistical significance of the relationships.

Chapter 4

RESULTS

4.1 Introduction

The results are divided into the following three sections: Section 4.2 Site description of Las Huertas; Section 4.3 Dispersed tree resources related to farm size, land tenure, livestock and gender; and Section 4.4 Description of tree species and assigned uses.

4.2 Site Description

Population

All households in the research area (Las Huertas) were visited during the research period of June 17 to August 3, 1996. The recorded population of Las Huertas participating in the survey was 238 persons. Based on observation by the researcher during community social events, a total population of 250[2] was estimated. Interviews were conducted with 43 of the 48 households (90 %) in the community. Five households were not included in the survey: one person was sick and unavailable; one household was removed because they were temporary non-farming visitors to Las Huertas; and three households had no interest in participating.

The household member primarily responsible for the preparation, planting, care and harvest of the staple field crops was interviewed. There were five female and 38

[2] Although "no-response" persons did not wish to be included in the survey, they participated in community activities, which made it possible to observe the number of persons per household.

male survey respondents of the households surveyed and both groups averaged 44 years of age. The number of persons per household ranged from one to eleven, with six being average. Level of school attendance for 12 respondents averaged five years (range one to nine), but most respondents (31) had no formal schooling background.

Settlement

The area of Las Huertas has been settled for approximately 50 years. A large ranch was divided into individual parcels and purchased by settlers in the 1940's. Many families relocated to Las Huertas from other nearby towns in eastern El Salvador and only the most recent settlers have arrived from distances greater than 20 km. Sixteen families (37 %) have lived in Las Huertas 40 years or more. Two residents reported that they had settled in the area even before the area was parceled into individual plots and had been residing in Las Huertas for 60 years. On average, the length of residency was 32 years, and many of these households are comprised of the sons and daughters of the early residents.

In Las Huertas, there was a state run primary school with two grades and two houses that sold dry-goods, vegetables, oil and kerosene. There was only one church in the community, a Roman Catholic chapel. There is no electricity, running water, phone, health post, or government office in the community. Although there are several foot paths to arrive or leave the area, only one road was passable for motor vehicles. Las Huertas is serviced by one bus line that makes two return trips daily to San Miguel.

Agriculture

Las Huertas is an agriculturally based community where 40 of 43 households actively cultivate a plot of land every year. The term "plot" refers to a parcel of land with specific boundaries used for the cultivation of crops or grazing of livestock. Farming in Las Huertas is exclusively a manual operation relying on implements such as hoes, machetes, and planting sticks.

All landowners of Las Huertas resided within the community and some rented land to other residents. In the case of one owner, he was farming one section of a field whose other sections he had rented to three other farmers. During the interview process, several farmers described the typical rental agreement: one 100 lb. bag of sorghum per hectare of rented land plus the crop residues.

There were a total of 76 farm plots actively cultivated in 1996. In total there was more owned land being cultivated than rented land and plot size averaged 0.93 hectares ($n = 75$) (Table 1). Owned plots averaged significantly larger ($P < 0.001$) at 1.12 hectares compared to rented plots which averaged 0.69 hectares (Table 1).

Maize-sorghum intercropping accounted for 55 % (37 ha) of all cultivated land. A higher number of rented maize-sorghum fields were planted in the early growing season (17) as compared to the late growing season (5), while owners planted almost equally in both growing seasons (Table 2).

The typical maize-sorghum planting cycle begins with weeding and herbicide spraying in early May and the planting of 120-day maize after the early rains in May and June. Approximately 21 days later, after the maize flowers, 160-day sorghum or beans are interplanted with the maize. In September, the maize stalk is doubled over to temporarily dry the maize in the field and facilitate the flow of water off the husks, to diminish grain spoilage. Sorghum flowers in October or November, and is ready for

Table 1. Total number of cultivated fields and mean field size in hectares by land tenancy from June to August, 1996 in Las Huertas, El Salvador.

	Number of fields	Hectares in cultivation	Mean field size (ha)
Owned land	42 (57 %)	47	1.12***
Rented land	33 (43 %)	23	0.69***
Total	75 (100 %)	70	0.92

*** Significant difference in sample means of owned and rented field sizes (independent samples t-test for equality of means $P< 0.001$)

Table 2. Total number of maize-sorghum fields in early and late planting seasons (1996) by tenancy in Las Huertas, El Salvador [a].

	Early season	Late season	Total
Owned field	9	11	20
Rented field	17	5	22
Total	26	16	42

[a] Although late season fields were not sown during the research period it was possible to visit these fields because they were being cleared and prepared for planting.

harvest sometime in January or February. Late season planting closely follows the procedure as described above, but usually begins after late rains in September. Once all grain for both growing seasons has been taken out of the fields in December and January, cattle are released to graze crop residues.

There were a variety of domesticated animals found in Las Huertas including: bovine, equine, porcine, and fowl. The 76 hogs counted in the survey were generally allowed to free-range during the day and were pen fed at night. The 18 horses were used to work on the six cattle ranches within Las Huertas or as transportation. Seven farmers with cattle, rotated their fields between annual crops, pasture and fallow over a period of four to six years. After the cropping years were completed farmers would sow a local, unimproved grass to form a pasture, within which would regenerate woody species such as *Mimosa tenuiflora*, *Acacia farnesiana*, and *Mimosa platycarpa*.

The most common animals sold were dairy cows and calves. Four farmers reported that the need to acquire money was the reason for selling those animals and others stated a variety of reasons such as a barter or age. Only one farmer went on to specify that he purchased seeds and pesticides with profits from his livestock sales. Six farmers sold their animals within Las Huertas and only one farmer auctioned his livestock in San Miguel (18 km).

Forty households (93 %) reported fruit bearing trees planted around the home. In 32 cases (74 %) the respondent stated that they were responsible for establishing the fruit trees. There was a total of 281 fruit trees among all 40 households, thus each household had an average of three different tree species and seven trees total. Appendix F contains a list of the 15 fruit tree species that were planted and the percentage of households where these tree species occur.

4.3 Dispersed Tree Resources in Las Huertas

Species Diversity and Number of Trees According to Farm Size, Land Tenancy, and Number of Livestock Owned

A total of 1,391 dispersed trees of 52 different species were found on 58 fields and eight fields had no trees on them at all. A complete list of the scientific and local names of the dispersed tree species found in the research area is available in Tables 1 and 2 of Appendix B and family, genus and species names with author are in Appendix H. Several statistical analyses were used to test the relationships of agricultural data such as farm size, land tenure, and livestock ownership with dispersed tree data such as total number of trees, species diversity and trees per hectare. The total number of dispersed trees according to farm size and land tenure were quite different, but this difference was not statistically significant (Table 3). Species diversity of dispersed trees was not statistically different across farm size or land tenure (Table 3). There was a higher tree density (trees/hectare) on owner cultivated land than renter cultivated land, and the difference was significantly different ($P < 0.05$) (Table 3). In addition, a greater number of trees per species were found on owner cultivated land in comparison to renter cultivated land, although the difference was not statistically significant ($P < 0.10$) (Table 3). There was no statistical difference between the number of livestock owned and number of dispersed trees or species. Pearson correlation analysis indicated that the correlation coefficient was not statistically significant and the association was not strong

Table 3. Total number of dispersed trees and species number per cultivated field according to land tenancy found on fields from June to August, 1996 in Las Huertas, El Salvador .

	Owned land (47 ha)		Rented land (23 ha)		All land (70 ha)	
	total	trees/ha [b]	total	trees/ha [b]	total	trees/ha [b]
Number of trees	1,003	38[c]	388	18[c]	1,391	31
Number of species	46[a]	7	33[a]	6	52	7
Trees per species	262	8[d]	85	3[d]	346	6

[a] Many of the 52 species encountered in the study occurred on both owned and rented land.

[b] The average number of trees per hectare was determined by calculating the number of trees per hectare for each individual field and then averaging that number across all fields.

[c] The number of trees per hectare on owned and rented land were found to be significantly different at $P < 0.05$ by independent samples t-test for equality of means.

[d] The number of trees per species per hectare on owned land and rented land was not found to be significantly different at $P < 0.10$ by independent samples t-test for equality of means.

(.283 and -.218 for species diversity and total trees)[3]. An inverse measure of association between the number of livestock owned and number of trees per hectare (-.434) was also not statistically significant and only slightly stronger.

Farmer Management Practices and Use of Dispersed Trees According to Land Tenancy

Ten main uses were identified by respondents for the 52 tree species encountered during data collection. A comparison of results from Table 4 and Table 5 indicates that farmers, whether owners or renters, identified the same uses for similar tree species. For example, there were 48 cases where a renter farmer considered a tree to have primarily a construction purpose (Table 4), although construction use by the renter was inaccessible in 85 % of these cases (Table 5). Similarly in other cases, furniture and tools were the primary uses identified even though access to the tree for these purposes was prohibited or by permission only. In contrast, the use of fruit, shade, and cutting of branches for posts, were relatively unaffected by tenure usufruct restrictions. The largest difference between owner and renters occurred with forage uses where renter farmers identified a species for this purpose in only two cases in comparison to 24 cases of owner farmer designation. Tenure affected the accessibility to some of the most commonly found species in Las Huertas (Table 6). Certain species were considered more valuable for construction purposes such as *Cordia alliodora* and *Karwinskia calderoni calderonii*, and access to these species was unrestricted by the land owner. *Guazuma ulmifolia*, in comparison was not restricted in 17 cases and unrestricted in only four cases.

Tree measurement data were also collected among 21 species for 10 % of the dispersed trees found in the study and are included in Table 7. In total these data were

[3] Linear association is measured between -1 and 1, with zero indicating no association.

Table 4. Number of cases of farmer assigned tree uses by land tenure for dispersed trees in Las Huertas, El Salvador in 1996.

	Land Tenure		
Use	Owned	Rented	Total
construction wood	68	48	116
fuelwood	62	33	95
fruit	34	15	49
posts	28	17	45
shade	22	18	40
furniture wood	16	12	28
forage	24	2	26
tool wood	9	14	23
other	7	6	13
medicine	8	3	11
nothing		2	2
Total	278[a]	167[a]	445

[a] The number of uses identified is greater than the number of tree species counted since some species have multiple uses as identified by farmers.

Table 5. Access by renter farmers to uses of dispersed trees found on rented land in Las Huertas, El Salvador from June to August, 1996.[a]

Use	Access restrictions		
	no restriction	access prohibited	allowed by terms[b]
forage	n.a.[c]	2	n.a.
fuelwood	14	16	3
fruit	13	2	n.a.
shade	17	1	n.a.
medicine	2	1	n.a.
furniture wood	n.a.	11	1
tool wood	n.a.	9	3
construction wood	3	41	4
posts	10	6	1
other	4	2	n.a.
Total	63	91	12

[a] These are cases where farmers assigned a particular use to a specific tree species.

[b] Access in these cases was permissible through an agreement between the owner and another interested party, typically a renter farmer.

[c] In certain cases access restriction categories are not represented because access restriction did not apply to all cases.

Table 6. Access by renter farmers to the use identified by them for the most commonly occurring dispersed trees species found on land rented in Las Huertas, El Salvador from June to August, 1996.

Tree species	Access restrictions		
	no restriction	access prohibited	allowed by terms[a]
Cordia alliodora	1	20	2
Guazuma ulmifolia	17	4	1
Simarouba glauca	11	11	2
Mimosa tenuiflora	9	3	1
Enterolobium cyclocarpum	1	5	n.a. [c]
Cordia dentata	2	4	n.a.
Karwinskia calderoni calderonii	n.a.	7	2
Lysiloma divarticatum	n.a.	4	n.a.

[a] These are cases where farmers assigned a particular use to a specific tree species.

[b] Access in these cases was permissible through an agreement between the owner and another interested party, typically the renter farmer.

[c] In certain cases access restriction categories are not represented because access restriction did not apply to all cases.

Table 7. Number of trees, diameter at breast height (d.b.h.), height, and crown diameter for a sample of the most commonly occurring trees found in fields June to August, 1996 in Las Huertas, El Salvador [a].

Scientific name	Number of trees sampled	d.b.h. (cm)	height (m)	crown diameter (m)
Cordia alliodora	55	7.6	6	3.3
Guazuma ulmifolia	7	58	10	7.3
Simarouba glauca	11	25	7	6.7
Mimosa tenuifolia	34	5	4	4
Lysiloma divarticatum	7	18	10	7.3

[a] Only 10 % of the dispersed trees were measured.

collected on eight farms (19 %) in the research area. Due to time constraints the collection of these data was halted shortly into the study. However, there are a few results that have some interpretive value when looking at other data collected concerning tree use and management.

4.4 Uses of Dispersed Trees in Las Huertas

Knowledge of local tree species use for items such as fuelwood, fruit, construction, and posts was common among households, while fewer households also identified medicinal, tool wood and fodder species as additional uses for some tree species. Results concerning each tree use by species are described in the following sections.

Fodder

Farmers reported using eight tree species for fodder and unanimously indicated *Guazuma ulmifolia* as a first choice. Five farmers stated that they procured the majority of their tree fodder from their property fence rows and three procured the majority of their fodder from dispersed trees within their cultivated fields.

Two farmers recommended *Gliricidia sepium* as a fodder. The farmer who considered fodder the most important use of *Gliricidia sepium* employed it exclusively as a silage component for his cattle. One farmer recommended that cattle may also eat the young leaflets of *Mimosa tenuiflora* and three farmers reported that swine relish the ripened drupe fruits of *Cordia dentata*. Twelve of 19 farmers (63 %) with cattle reported using tree fodder during the dry season.

Detailed information from the survey concerning fodder use of any dispersed tree recorded in the study is included in Table 1 of Appendix E.

Fuelwood

The importance of a fuelwood supply is considerable because all the households surveyed depended on fuelwood for cooking and household needs[4]. Thirty households (70 %) reported using a total of twenty-seven species (52 %) for fuelwood and the three species most preferred were *Mimosa tenuifolia*, *Cordia alliodora*, and *Guazuma ulmifolia*.

Fuelwood was often the first use for the residual wood left after a previous use had caused the removal of the tree (i.e. construction, post, or furniture) or for branches that had been pruned for shade. Thirteen species (25 %) were considered useful only as fuelwood by 15 farmers (35 %).

Detailed information from the survey concerning fuelwood use of any dispersed tree recorded in the study is included in Table 2 of Appendix E.

Fruit

Twenty-four surveyed households (56 %) were farming fields with fruit bearing species as dispersed trees. Many of the same fruit tree species were planted in the home gardens (11 of 52 species [21 %]). The majority of these fruit trees were volunteer, although one farmer indicated he had planted some of the fruit trees.

Detailed information from the survey concerning fruit use of any dispersed tree recorded in the study is included in Table 3 of Appendix E.

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[4] A few homes were equipped with a gas stove, but this was not the preferred cooking method and gas was difficult to obtain.

<u>Medicine</u>

Seven households (16 %) recommended using specific dispersed trees for medicinal purposes. In total they described the preparations necessary for six (11 %) tree species found in the research area.

The most commonly suggested species for both humans and domestic animals was *Guazuma ulmifolia*, which was recommended by six households (14 %). Five other species were mentioned by two farmers as effective for a variety of ailments.

Detailed information from the survey concerning medicinal use of any dispersed tree recorded in the study is included in Table 4 of Appendix E.

<u>Construction</u>

Farmers indicated several ways to utilize local tree species for construction purposes with 27 dispersed tree species (52 %) being recommended by 34 households (79 %). Fifteen farmers (35 %) identified six species (11%) most often used as corner-posts for houses and out-buildings. Eight farmers had *Lysiloma divarticatum* in their fields and unanimously reported that this tree was to be used precisely for this construction purpose. *Karwinskia calderoni calderonii* and *Gliricidia sepium* were also identified as corner-post species by four and three farmers, respectively. Three other species, *Chlorophora tinctoria*, *Mimosa tenuiflora*, *Caesalpinia coriaria* were identified by two farmers.

Small branches or trunks of four other tree species were recommended as inner support structures for walls by 10 households. Interview results indicated that *Cordia dentata* and *Mimosa tenuiflora* were most frequently used in this manner, five (11 %) and four (8 %) farmers mentioning each species, respectively. Two other species, *Guazuma ulmifolia, Casearia corymbosa* were also suggested for inner wall structures.

Detailed information from the survey concerning construction use of any dispersed tree recorded in the study is included in Table 5 of Appendix E.

Furniture Wood

Eighteen farmers (42 %) indicated that 10 tree species (19 %) were used for furniture wood construction. There were several species that were frequently suggested *Cordia alliodora* and *Simarouba glauca*, while another eight species identified were only mentioned once each by farmers.

Detailed information from the survey concerning furniture use of any dispersed tree recorded in the study is included in Table 6 of Appendix E.

Posts

Twenty-six households (60 %) recommended using 14 local tree species (27 %) as fence posts. The most commonly suggested fence-posts was *Mimosa tenuiflora* which was mentioned by 15 farmers (35 %) and *Cordia dentata* mentioned by 10 farmers (23 %).

Detailed information from the survey concerning post use of any dispersed tree recorded in the study is included in Table 7 of Appendix E.

Farm Tools and Domestic Implements

Six farmers (14 %) described six species (11 %) as useful for general tool handle purposes, such as for a curved machete, planting stick, or hoe. Farmer opinion was unanimous that small diameter, yet hard branches of *Tabebuia impetiginosa*, *Chlorophora tinctoria*, *Psidium guava*, *Luehea candida*, *Cresentia alata*, *Cordia alliodora* should be used for these implements. Eight farmers specifically mentioned that four species, *Chlorophora tinctoria*, *Caesalpinia coriaria*, *Lonchocarpus minimiflorus*, *Karwinskia calderoni calderonii* were excellent for wagon axles.

Detailed information from the survey concerning tool wood use of any dispersed tree recorded in the study is included in Table 8 of Appendix E.

<u>Shade</u>

Twenty-one farmers (48 %) stated that 21 species (40 %) were useful as shade trees. Ten farmers (23 %) reported that the primary users of shade trees were animals and 13 additional farmers (30 %) stated that shade was also used by humans while resting from field work. The most frequently recommended shade species were *Guazuma ulmifolia*, *Enterolobium cyclocarpum*, *Simarouba glauca*, and *Andira inermis*. A similar number of species were identified as useful for humans and animals, 12 and 13, respectively although only six were the same species.

Detailed information from the survey concerning shade use of any dispersed tree recorded in the study is included in Table 9 of Appendix E.

<u>Other Uses</u>

Eight households described uses for five tree species (10 %) which deserve special attention. For example, five households (12 %) recommended the pressed and processed fruits of *Simarouba glauca* as an excellent source of soap for general and hygienic purposes. Two farmers stated that *Ceiba pentandra* is very useful as a boat and one farmer recommended using the fluffy endocarp of opened seed pods as stuffing for a mattress or pillow. Two other farmers stated that *Gliricidia sepium* and *Mimosa tenuiflora* could be used in the preparation of organic pesticide and blacksmith furnace fires, respectively. One farmer stated that tannins extracted from *Caesalpinia coriaria* fruits can be used for tanning leather hides. Two households specified that fruits of several species such as *Spondias purpurea* and *Cresentia alata* had religious purposes.

Detailed information from the survey concerning other uses of any dispersed tree recorded in the study is included in Table 10 of Appendix E.

Chapter 5

DISCUSSION

5.1 Dispersed Tree Resources

To understand the dispersed tree agroforestry system in Las Huertas requires an appreciation of farmers needs, of tree species uses, of tree biology, and the complexities of land and tree tenure. The study found that the trees left in fields during land clearing and cropping were selected on the basis of potential tree use and farmer experience. Individual farmer needs dictate when and for what purposes dispersed trees are removed from the fields. Therefore the balance of current household needs and future potential needs were always impacting what "appears" on the farming landscape in any given year.

Results from the study indicated that there was a higher tree density per hectare on owned land than rented land (38 trees/hectare of owned land in comparison to 18 trees/hectare of rented land). It may be that owner farmers elect to retain more trees on their land than renter farmers because they will ultimately utilize all the benefits of the dispersed tree. While renter farmers, although they recognize similar uses as owners for dispersed trees (Table 4), may decide to leave certain species according to the amount of access and benefits they ultimately receive (Table 5). For example, a higher number of dispersed *Cordia alliodora* were found on owned fields than rented fields (Table 8) and renter use of this species was restricted in 22 out of 23 cases (Table 7). In contrast, *Guazuma ulmifolia* were accessible to renter farmers in 17 out of 22 cases (Table 7) and occurred in more than twice as many fields on rented land than owned land and in double the number (Table 8).

Results also indicate that similar tree species are kept by both types of farmers because these species are important to farmers as multiple purpose trees, which are not removed from the field through a one-time use (Table 9). Certain species listed in Table 8 are retained in higher numbers of individual trees than others, while the number of fields they occur in may be quite similar. For example, *Guazuma ulmifolia* and *Simarouba glauca* were represented by 52 and 47 trees, respectively, and occurred in 21 fields; yet these two species served a wide variety of purposes such as fodder, fuelwood, medicine, fruit, posts, construction and tool wood (Table 9). Other species such as *Mimosa tenuiflora* and *Cordia alliodora*, which served uses such as fuelwood, construction, tool wood, and furniture, were represented by 521 and 292 trees and occurred in 21 and 22 fields, respectively. These differences in tree number may be understood by examining the management practices involved to access the use. Some tree uses such as construction or furniture wood require tree removal, while others such as fodder, fuelwood, and medicine uses require only the pruning of the crown. Thus, the use of *Mimosa tenuiflora* and *Cordia alliodora* tend to result in their removal for construction purposes, while the use of *Simarouba glauca* and *Guazuma ulmifolia* tend to allow them to remain standing in the fields. Since these species are removed it appears that this may be one explanation as to why there are large numbers of trees for these species and lower numbers of trees for other species that are not typically removed through use.

Results also indicate that the overall species to hectare ratio of seven species per hectare is lower than results from other areas of the world. For example, in a study from

Table 8. Number of trees, number of fields, trees per field and number of farmers who retained the most commonly occurring trees found in fields from June to August, 1996 in Las Huertas, El Salvador.

Scientific name	Owned land			Rented land		
	farmers	fields	trees	farmers	fields	trees
Mimosa tenuifolia	12	14	365	7	7	156
Cordia alliodora	9	10	208	11	12	84
Cordia dentata	8	8	94	3	3	4
Enterolobium cyclocarpum	7	9	82	5	5	11
Simarouba glauca	10	12	27	8	9	20
Lysiloma divarticatum	6	7	25	2	2	13
Guazuma ulmifolia	6	7	16	13	14	39
Karwinskia calderoni calderonii	3	4	12	5	5	9

[a] Total number of farmers who had this tree in fields they were cultivating in 1996.

[b] Total number of fields were this tree occurred in 1996.

[c] Total number of trees for this species that occurred on these fields in 1996.

Table 9. Number of trees, number of fields, trees per hectare and particular uses assigned the most commonly occurring trees found in fields from June to August, 1996 in Las Huertas, El Salvador.

Scientific name	Trees [a]	Fields [b]	Trees/Ha [c]	Uses [d]
Mimosa tenuifolia	521	21	28.7	C, D, F, P
Cordia alliodora	292	22	13.9	C, F, L, N, S
Cordia dentata	98	11	12.6	C, D, F, P, S
Enterolobium cyclocarpum	93	14	8.7	C, D, F, P, S
Guazuma ulmifolia	55	21	4.9	C, D, F, G, M, P, S, T
Lysiloma divarticatum	38	9	4.4	C, D, F, P
Karwinskia calderoni calderonii	21	9	3.6	C, F, L, P, S
Simarouba glauca	47	21	3.2	C, F, N, O, S, T

[a] Total number of trees of this species found in cultivated fields in 1996.

[b] Total number of fields were this species occurred in 1996.

[c] Average number of trees/hectare for this species that occurred on these fields in 1996.

[d] Uses: C = construction wood; D = fodder; F = fuelwood; G = nothing; L = tool wood; M = medicine; N = furniture wood; O = other; P = posts; S = shade; T = fruit.

Rwanda, two farmer groups (control farmers and tree experts) were surveyed and each had 11.7 species/farm and 34.4 species/farm on farms that averaged 0.18 and 1.27 hectares, respectively (den Biggelar and Gold 1996). Two explanations for the difference in species diversity may be: 1) Salvadorans are acquiring resources to meet their needs from other sources such as home gardens, live fence-posts, live fences, or riverine forests; and/or 2) the lower population pressures in Las Huertas of 74 persons/km^2 are significantly less than the 423-533 persons/km^2 for Rwanda. Under these comparative circumstances off-farm resources in Las Huertas may still exist to a greater extent than would other wise be considered.

Nevertheless, the presence of dispersed trees on fields in Las Huertas does indicate that farmers have adopted intensified agricultural practices to satisfy their needs of timber, fuel, and food. Scherr (1995), in an evaluation of farmer agroforestry adoption practices in Kenya, stated that Kenyan farmers historically adopted agroforestry technologies as "induced innovations" as identified by Raintree and Warner (1986), and that agricultural practices became increasingly intensive as population increased and shifting cultivation patterns decreased. The population of El Salvador tripled between 1900 and 1960, and has continued to grow at 1.6 % for the last decade (USAID 1996). In this setting unclaimed farm land has become non-existent and forest resources have diminished as urban and rural demand for wood products continue to increase (Barry *et al.* 1996). Also, Scherr (1995) commented that farmers adopt agroforestry practices when the benefits of the adopted practice are more advantageous than the staple crop or cash crop production. Results of this study indicate that Salvadoran farmers have knowledge concerning the use of dispersed trees and retain these species because the products and benefits are of greater value than staple crops. Finally, Scherr (1995) described that Kenyan farmers adopted species which adequately met their needs. Salvadorans farmers likewise, did not adopt "trees", or even "trees and crops" but specific species that met specific needs and which could be incorporated into their agricultural landscape.

Another explanation for varying number of trees has to deal with morphological differences between species. Tree species that have crowns which create dense shade due high numbers of leaves and branches were less frequently found than crowns which allowed greater light penetration to the soil surface. For example, the *Cordia alliodora* found in the study were straight, fast growing, columnar shaped tree with few branches, sparse foliage, averaging 6 m in height and 3.3 m in crown diameter (Table 7) (Plate 1 of Appendix A). The shading affect of these trees was minimal, crop loss was not an expressed concern of farmers, and lower branches were not pruned. There were 13.9 *Cordia alliodora* per hectare, which is 4 to 6 times greater than the number of other species with heavier crowns such as *Simarouba glauca* (Plate 2 of Appendix A) and *Guazuma ulmifolia* (Plate 3 of Appendix A) respectively. There were only three to five trees of the latter species per field and these trees averaged 6.7 and 7.3 m, respectively in crown diameter. Several farmers mentioned that trees with this type of crown reduced crop yields due to shading so fewer trees were retained (Table 9). This is similar to *Borassus flabellifer*, a palm which farmers retain as dispersed trees and on paddy bunds in Tamil Nadu, India (Jambulingam and Fernandes 1986). Because the tree has a small round crown it produces negligible shading effects and farmers typically leave between 100 - 150 of these palms per hectare. At the same time, Tamil Nadu farmers keep certain trees with heavy dense foliage out of the best crop producing fields, and instead they prefer to establish these trees on poor sites that have low crop production. Thus, by planting fruit-bearing *Tamarindus indica* on poor sites they compensate for crop yield loss through fruit production and sales which is of higher value to the farmers.

5.2 Description of Tree Use and Management Practices

Other examples will be considered in the following sections which describe farmer use preferences and management for the myriad of dispersed tree species found in Las Huertas.

Fodder

Small farmers in developing countries often use tree leaves, seed pods or tender branches as supplemental feeding sources for livestock. Often the nutrient levels in tree or shrub fodder sources will fluctuate less annually and remain higher during the dry-season than common grown pasture grass species which tend to loose nutritive value (Crowder and Chheda 1982). Crude protein levels, for example become significantly more important in the dry season when these levels decrease in grasses, while tree fodder levels remain constant and sometimes twice as high as the grasses (Crowder and Chheda 1982).

The use of a tree fodder as an alternative feed source during periods of limited resources, such as the dry season, has been found elsewhere. For example, Costa Rican farmers reported 51 species that were potentially useful as dry-season fodder (Araya *et al.* 1994). Fur farmers in the Sudan harvested lopped branches of *Acacia albida* to feed to their livestock (Miehe 1986). Jamaican farmers used locally available inexpensive tree leaves and fruits as alternative dry season feed for their cattle (Morrison 1991). Nepalese farmers were reported to use over 40 trees or shrubs as fodder sources in one study (Fonzen and Oberholzer 1984). In addition, Nepalese farmers have been found to distinguish between fodder sources that render desirable properties to the cow's milk and butter products (Rusten and Gold 1991). Thus, consistent with the use of these resources is a local knowledge about which trees provide the best fodder.

Six farmers (54 %) mentioned *Guazuma ulmifolia* as a fodder source, and four ranked this use as the most important for this tree. *Guazuma ulmifolia*, a native, medium size tree (2-15 m high) with thick dark green, deciduous foliage only shedding its leaves for a brief period near the end of the dry season, is commonly used as a fodder source (Morrison 1991, Herrera and Morales 1993, Geilfus 1994). All six farmers reported that the new leaves which appear in April and May are the most desired source of fodder from *Guazuma ulmifolia*. Young *Guazuma ulmifolia* leaves are estimated to have 16-17 % crude protein which is important for animal health, growth, production and reproduction (Crowder and Chheda 1982, Geilfus 1994, Medina *et al.* 1994). Also, foliar nutrient analysis revealed that *Guazuma ulmifolia* has a high nitrogen content (3.21 % dry-weight) and a low total fiber content (27.63 % neutral detergent fiber), a particular combination that is favorable for bovine fodder digestability (Hunter and Stewart 1993). Besides leaves, the fruits of *Guazuma ulmifolia* have also been found to have crude protein (7.9 %) nutritive value (Bressani *et al.* 1981). It was recommended that the fruits be used as a dried and milled feed supplement and added to normal rations at levels < 30 % of total feed. Supplements levels > 30 % were found to contain high lignin and tannin compounds, which contributed to poor digestability, poor digestability and negatively affected weight gain in study animals (Bressani *et al.* 1981, Hunter and Stewart 1993, Humphreys 1994).

Live fence posts and dispersed trees are primary sources of *Guazuma ulmifolia* fodder for farmers in Las Huertas. A strong branch regeneration capability after heavy coppicing was described by one farmer as important for the trees' ability to replenish the fodder source. Dispersed *Guazuma ulmifolia* trees often had a large trunk (d.b.h. 58 cm), relatively small crown diameter (7.3 m), many (10-20) straight small diameter branches (3-10cm), and few large limbs perhaps as a result of lopping and coppicing activities (Plate 3). Good regeneration potential was also common for tree species found in areas where tree fodder branches were periodically lopped (Meihe 1986).

Farmers indicated that some species were excellent fodder sources yet no activity was necessary on their part other than allowing the animal to graze where the pods have fallen. One particular species, *Enterolobium cyclocarpum* was recommended by five farmers as useful fodder during the last month of the dry season. The ripe fruits fall before the first rains and usually contain 6-16 seeds within a sweet gum-exuding pod, and serve as an excellent fodder source that foraging animals consume (Janzen 1982). The leaves and pods of *Enterolobium cyclocarpum* are protein sources containing up to 36 % and 17 % crude protein, respectively (Herrera and Morales 1993, Geilfus 1994).

Interview results also revealed that the seed pods of four other species (*Lysiloma divarticatum*, *Cassia grandis*, *Pithecellobium saman*, and *Caesalpinia coriaria*) were recommended as fodder by seven farmers. No farmer mentioned using leaves of these species as fodder sources. The preference for pods over leaves has been noted in Ethiopia where farmers value the copious quantities of *Faidherbia albida* pods as dry-season fodder more than the leaves (Poschen 1986).

The nine fodder species identified by farmers were also identified for an average of four other uses such as fuelwood, posts, medicine, and fruit. Fodder production management by farmers did not restrict the use of these tree for the other stated purposes. Araya *et al.* (1994) in a comparative review of the literature found that a multiplicity of uses were identified by Costa Rican farmers for the 51 fodder species they identified for researchers. For example, cattle grazing on fallen seed pods and leaves do not eliminate the tree from being used for other uses such as shade and branching pruning for fuelwood. The multiple uses of fodder trees has also been recorded by other researchers (Fonzen and Oberholzer 1984, Meihe 1986, Budowski and Russo 1993).

Fodder use of tree species was considered a much less important use of the trees by renters that owners (Table 4). *Guazuma ulmifolia* was the only species mentioned by two renters as a fodder source, but they did not have usufruct rights to the tree for fodder. All other farmers (10) who mentioned use of tree fodder were owners of bovine animals and had the rights of fodder use otherwise denied to renters. Limited access and ownership of bovines appears to have impacted the importance of fodder uses that were identified in the survey. The overall impact on the survey is considered negligible since other uses considered important by renters and owners such as construction and furniture were also restricted.

The use of alternative food sources for cattle during the dry season such as tree fodder can impact milk and cheese production. Generally, farmers reported that wet season milk production averaged 60 % higher (5.7 bottles per cow per day) than dry season production (2.25 bottles per cow per day). Dry season food sources such as residues, concentrate and tree fodder should be seen to function together as complimentary sources of fiber and protein, with different rates of digestibility (Humphreys 1994). Nine of the 13 cattle owners tried to maintain milk production levels during the dry season by supplementing the use of crop residues with tree fodder resources or a diet of high energy sorghum and molasses concentrate or some combination. Milk production rates varied by only 5 % for those farmers who were feeding some combination of concentrate, crop residues, and tree fodder during the dry season. Four farmers who did not supplement their cattle's diet of crop residues with tree fodder during the dry season found milk production to drop by 67 %. Although crop residues are abundant in the field after harvest, residues typically have a low crude protein content, low digestibility rate and are a poor energy source to maintain milk production (Crowder and Chheda 1982).

Another side effect of using crop residues for cattle production is the loss of soil protection by the removal of crop residues. The amount of soil erosion has been shown to be significantly increased on fields where crop residues have been removed (Sosa and Bolaños 1993). A recent report from El Salvador stated that, "more research and extension on improved sources of animal feed during the dry period could help alleviate pressure on crop residues", which would through time decrease soil erosion rates and increase crop yields (Sain and Barreto 1996:320). Traditional fodder sources, such as those used in Las Huertas could provide improved food sources to meet these research needs.

Fuelwood

Fuelwood is traditionally gathered from a variety of sources in El Salvador such as forest wood lots, roadsides, live fences, and coffee plantations. Forest wood lots however are often privately owned and wood use is restricted to the owners. Roadsides are often as communal fuelwood sources, but as common property collection is unmanaged and random. Live-fences, a common landscape features in some parts of El Salvador and other parts of Central America, provide not only fuelwood as needed but additional products such as fruit, shade, medicine, and posts (Sauer 1979, Budowski and Russo 1993).

The exclusive use of fuelwood for cooking and the restricted number of trees accessible in the study area requires households to be imaginative in finding sources of fuelwood. Within Las Huertas, dispersed trees also serve as important fuelwood sources for the households in Las Huertas. Thirty-one households (72 %) used 27 dispersed tree species (52 %) as fuelwood. They were used fuelwood in three distinct ways: 1) use of branches pruned to mitigate crop loss due to shading 2) use of removed limbs and branches after felling the tree for construction purposes, and 3) wood collected during clearing of fallow fields or pastures.

Lower branches of dispersed trees are pruned when the farmer decides that shade will interfere with crop production. Renting farmers also had the incentive to prune lower branches since they were able to use these branches. A renter did caution however, that excessive pruning was not acceptable and that removal of the entire tree was definitely prohibited. In general, fuelwood from dispersed trees was a by-product of management goals within the field. This is not an unusual practice, for example in the past, the oak parklands in southern Spain were also managed for very similar purposes: mitigate shade and provide material for charcoal production (Parsons 1962, Jofre *et al.* 1988). Farmers in Burkina Faso pruned *Parkia biglobosa* to rejuvenate tree health, control insect pests, and increase fruit production, however the by-products served as fuelwood (Kater *et al.* 1992, Kessler 1992, Tilander *et al.* 1995). Similarly, farmers in Zimbabwe recognized that pruning branches of mango trees provided dual benefits of increased fruit production as management goal and fuelwood as the by-product (Musvoto and Campbell 1995).

Dispersed trees become another source of fuelwood when the primary use calls for tree removal. Eighteen households (42 %) reported using the small branches for fuelwood when trees were cut for construction purposes such as raising a house or barn. These uses were restricted to the owners of the land. Fifteen species identified for construction, such as *Lysiloma divarticatum*, *Cordia alliodora*, and *Karwinskia calderoni calderonii*, were also identified as good for fuelwood material. The complete use of a harvested tree is commonplace in Las Huertas given the need for fuelwood on a daily basis.

Another important source of fuelwood was from the clearing of fallow areas for crop production. Fallow and pastures of the dry Pacific coast of Central America are typically invaded by *Mimosa tenuiflora*, a quick growing, nitrogen-fixing, multiple stemmed, thorny tree, that quickly establishes itself in abandoned areas (Plate 4 of Appendix A) (Allen and Allen 1981, Kass *et al.* 1993). Two clearing methods were observed in Las Huertas: 1) the main branches were cut off from the main stems and left to dry on the ground, and 2) the trees were felled to the ground.

The first clearing technique was observed on only one farm, and the farmer wanted to maintain live stems for future use as poles or posts. The second, more common clearing technique was for all branches to be cut as previously described and then the stem cut off about 10-20 cm above the ground. The cut material was left in the field so that the dried leaf litter would fall to the ground and decompose. The use of pesticides by farmers in Las Huertas for field preparation insured that nitrogen additions from leaf litter decomposition remained in the field. In a review of fallow systems in the Americas, Kass *et al.* (1993) compared the soil analysis from a 12-year-old *Mimosa tenuiflora* fallow with a 32-year-old secondary forest. It appeared from this comparison that the 12-year-old fallow had higher levels of organic matter, calcium, magnesium, and phosphorus as compared to the secondary forest. Investigations regarding the addition of soil nutrients such as nitrogen are needed to further understand these benefits of this field preparation and clearing technique.

Fruit

Interview results indicated that most fruits were collected and eaten without preparation from these tree species: *Brysonima crassifolia*, *Mangifera indica*, *Simarouba glauca*, *Psidium guava*, *Genipa americana*, *Anona reticulata*, and *Spondias purpurea*. The fresh fruit of several species however, required processing before consumption. For example, six farmers collected the fleshy seed coat and nutmeat of *Anacardium occidentale* which they made into juice or roasted, respectively. Farmers also recommended that the fresh fruits of some species such as *Cresentia cujete*, *Cresentia alata*, and *Guazuma ulmifolia* be processed into juice drinks either to refresh or treat stomach problems. Toasted and ground *Cresentia alata* seeds are combined with rice in a refreshing drink known as "horchata" (Castro 1978).

One farmer had field planted 34 improved *Anacardium occidentale* specimens from a community forestry project. These were the only dispersed fruit trees identified as planted within the study area. The majority of fruit trees established in Las Huertas were planted in homegardens. Data are insufficient from the Las Huertas study to make inferences concerning who made the fruit tree planting location decisions. However, it is possible that fruits trees were planted closer to the home to ensure better survival rates through better care and for a measure of protection against theft. One study, which reported a 50 % survival rate after four years for fruit trees established near the home, attributed this rate to the care and protection provided by women who chose to plant these trees in their homegardens (Hocking *et al.* 1996). Dispersed fruit trees are difficult to secure against theft of ripe fruits and would be more inconvenient to collect, while placement of fruit trees in the homegarden is convenient, secure and increases the likelihood of care and survival.

<u>Medicine</u>

Four households recommended *Guazuma ulmifolia* remedies to treat human health problems such as the loss of body fluids from dysentery. The remedy suggested was a tea made from crushed and boiled fruits or bark. Recently a scientific study verified, in part, this traditional remedy. Eighty-four traditionally used plants were screened and *Guazuma ulmifolia* was one of 10 species found to be an effective inhibitor of enterobacterium[5] which are pathogenic to man, and are commonly fecally transmitted or acquired through contaminated water sources (Caceres *et al.* 1990). Knowledge of *Guazuma ulmifolia* for medicinal purposes is widespread and has been used for medicinal purposes in Nicaragua, as well as El Salvador and Guatemala (Herrera and Morales 1993).

Two households suggested a *Guazuma ulmifolia* remedy if a cow has not discharged the placenta after birthing. In this situation, farmers recommended that a small portion of bark is steeped in water, the liquid is cooled, and given to the cow to drink, pouring it down the throat if necessary. Farmers stated during the interview, and key informants later corroborated, that this treatment is "100 % effective". The afterbirth is reportedly discharged within minutes after the cow ingests this liquid. Research describing the effects of *Guazuma ulmifolia* in this situation were not found in the literature.

Other species mentioned included *Eucalyptus* spp. as a tea for colds, *Genipa americana* and *Haematoxylon campechianum* against diarrhea and dysentery, *Exostema caribaeum* to treat fever, and *Cresentia cujete* for an unspecified illness. The latter four species were maintained on the farm of two key informants. *Genipa americana* and *Eucalyptus* spp. are also popular in Nicaragua for cold relief and diarrhea, respectively (Herrera and Morales 1993).

Inclusion of medicinal plants as live fence-posts and as dispersed trees has been reported in several studies. Budowski and Russo (1993) listed 21 species, grown as live fence-posts in Costa Rica that can serve in medicinal purposes. Three of these *Cresentia*

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[5] Enterobacteria: *Salmonella typhi* and *Shigella dysenteriae*

alata, *Eucalyptus* spp., and *Guazuma ulmifolia* were found in Las Huertas as dispersed trees and assigned the same medicinal use. A study from Rwanda reported that two-thirds of all species (106 of 152) which farmers planted on their fields were for medicinal purposes (den Biggelar and Gold 1996). These farmers stated that a wide variety of medicinal species was necessary given the disease/parasite curative specificity of many medicinal plants. Two species, *Simarouba glauca* and *Mimosa tenuiflora*, were not assigned medicinal uses in Las Huertas yet are described in literature sources as a febrifuge to reduce fever and as a very effective analgesic to treat burn victims, respectively (Armour 1959, Anton *et al.* 1993).

Construction

Locally available wood resources were commonly employed as posts, rafters, and to assemble walls for house and out-building construction in Las Huertas. Many of the older structures in Las Huertas are made of materials such as pole timber, clay, thatch, or tile, while more recently constructed houses are of saw timber, brick, and cement.

Household decisions to utilize dispersed trees for construction materials are made on a need-to-use basis. No household gave a time frame as to when it would use construction species (e.g. "in five years"), instead they all stated that tree resources were used as needed. During the research period, there were four construction projects in process. In each case there were several dispersed trees utilized.

Although there was a great variety of trees recommended for construction purposes, farmers were specific in their opinion about where and how certain species should be utilized. *Cordia alliodora* and *Lysiloma divarticatum* for example, are not only construction use specific (all farmers reporting first use as construction), but also certain functions within the house or out-building.

The corner-post is a very specific use that few trees were assigned. As a corner-post, a sawn tree trunk holds up the rafters, cross-beams, roof, and must have a forked top to do this effectively. Besides the forked end, the trunk must have a well developed heartwood to be reasonably termite and decay resistant when set into the earth for stability. Fifteen farmers (35 %) identified six species (11%) as corner-post species for a house or out-building. One species, *Lysiloma divarticatum* was unanimously reported by eight farmers to be used precisely for this purpose. In fact, when discussing the uses of this tree, the first response was always "forked corner-post" (*horcón*) and not under the general heading of "construction". *Lysiloma* spp. in general are heavy, dense woods with high specific gravity (0.63) and highly durable heartwood (Herrera and Morales 1993, Chudnoff 1980). Basic specific gravity (ovendry weight /green volume) is often used as a characteristic for assessing the use potential of a wood and may be related to important wood attributes such as mechanical strength and shrinkage, which are influenced to a great extent by cell wall thickness and component tissues. Durability is a general term used to describe a woods' resistance to termite and fungi attack (Chudnoff 1980). Assignment of durable, hard, dense woods found in Las Huertas to these particular uses provides evidence that local farmers recognize similar characteristics and attributes in wood species they chose to utilize. Similar expectations were reportedly demanded by the Fur people in the Sudan who utilized *Ziziphus spina-christi* as support poles for a roof only when the tree had attained a well developed trunk (Meihe 1986).

Five other species with high specific gravity and strong heartwood (Appendix C) were also recommended as corner-posts (*Gliricidia sepium*, *Chlorophora tinctoria*, *Mimosa tenuiflora*, *Caesalpinia coriaria*, and *Karwinskia calderoni calderonii*). Several species were commonly used as corner-posts and other heavy construction in other parts of Central America and the Caribbean (Rojas Chacón 1981, Geilfus 1994, Herrera and Morales 1993).

As mentioned, the corner posts hold up rafters, cross-timbers, and tiles and the farmers are specific about timber qualities for these uses. Farmers considered resistance to warping or checking as important qualities for rafter or roofing timber species. Whether sawn or simply striped of bark and used as a rough pole, farmers reported that a rafter needed to be, as one woman said, "true to it's shape year after year". This was critical because rafters or crossbeams are often laid into the forked trunk or secured together with nails or dowels to hold other portions of the roof in place. Any movement of the timbers in these positions would have negative effects on the longevity of the roof.

Two species *Calycophyllum candidissimum* and *Cordia alliodora* were mentioned by individual farmers as specifically useful for rafters and data concerning wood properties supports farmer recommendations. *Cordia alliodora* is described as a fast air-drying wood only slightly susceptible to warping and checking. The heartwood is durable, resistant to white-rot and brown-rot fungi, and shows good resistance to dry-wood termites (Chudnoff 1980). The availability of these quality trees is mentioned by Budowski (1993) who reported that *Cordia alliodora* trees growing in areas with distinct wet/dry seasons, like Las Huertas, develop a dark and very strong heartwood. *Calycophyllum candidissimum* is susceptible to some warping and checking if sawn into pieces smaller than rafters, and lacks durability to fungi (Chudnoff 1980). Similar uses for each species were recommended in other parts of Central America (Rojas Chacón 1981, Herrera and Morales 1993). Key informants stated that *Cordia alliodora* should not be used for any construction purpose that brings it in contact with the ground because it will be attacked by termites. Agreement on this point was not unanimous among farmers and the species has been reported as resistant to only dry-wood termites (Chudnoff 1980, Geilfus 1994, Witsberger *et al.* 1982).

Farmers used a practical measurement to describe when a tree was ready for construction purposes such as rafters or poles. When asked, "when do you use this tree for this purpose?", farmers typically used their hands to form a circle to illustrate a suitable tree trunk. Tree measurements in Table 7 for *Cordia alliodora* trees designated for construction uses fit the description of a future pole timber. Although not a precise scientific measurement this illustrates that farmers distinguish between pole timber and saw timber which was used for other purposes.

Certain species were mentioned as useful for the small cross-rafter poles upon which the tiles rest when the roof completed. Five farmers suggested that *Cordia dentata* be used for this purpose, and *Mimosa tenuiflora* and *Guazuma ulmifolia* were also mentioned. Two of these species (*Cordia dentata* and *Guazuma ulmifolia*) were managed through coppicing to produce long straight branches suitable for cross-rafter supports. In contrast, *Mimosa tenuiflora* stems, which typically produces numerous (1-6) long (2-3m) straight stems, were cut, dried in the field, removed, and used for building purposes. Poles for building purposes are also accessible through the coterminous tenure agreement for cultivated plots with cut fallow vegetation.

Ten households also suggested that straight branches or stems can be placed upright as the inner-wall support structures that are later covered over with clay and whitewash. Four species, *Cordia dentata*, *Mimosa tenuiflora*, *Guazuma ulmifolia*, and *Casearia corymbosa* were mentioned for this use. Similar to the cross-rafter uses, *Cordia dentata* and *Guazuma ulmifolia* could be managed to produce necessary branches and *Mimosa tenuiflora* grows straight stems suitable for this purpose. Also, it is possible that lopped branches initially removed for fodder could later serve as inner-wall supports.

More trees and more species of trees in Las Huertas were assigned construction uses by more farmers than any other use. Obviously, farmer opinion about construction trees represents a broad knowledge base that needs to be investigated before agroforestry interventions are begun in an area.

Furniture Wood

Eighteen farmers (42 %) identified 10 tree species (19 %), as light, easily worked woods for furniture construction or other specialty items. Products mentioned included tables, chairs, doors, and coffins. Renter farmers stated that tenure and access restrictions strictly prohibited use of tree for furniture (Table 4 and 5). These restrictions are similar to those for construction use, although one farmer indicated that use was possible through an agreement.

The majority of tree species assigned furniture uses were lighter and more easily worked than woods recommended for construction purposes. Correspondingly, the range of specific gravity measurements for more commonly mentioned furniture woods tended to be lower (0.34 to 0.52 for *Simarouba glauca* and *Cordia alliodora*, respectively) (Chudnoff 1980, Witsberger *et al.* 1982). Some species, for example *Simarouba glauca*, *Cordia alliodora, Ceiba pentandra, Enterolobium cyclocarpum, and Bursera simaruba* are only susceptible to minor warping and checking as saw lumber (Witsberger *et al.* 1982, Chudnoff 1980). Four species, *Chlorophora tinctoria, Cordia alliodora, Hymanea courbaril*, and *Swietenia humilis* are commonly used throughout Central America for fine furniture manufacturing; while other species *Enterolobium cyclocarpum* and *Simarouba glauca* are used for less expensive, more economical furniture (Armour 1959, Rojas Chacón 1981, Herrera and Morales 1993).

Furniture items are typically made from planks of saw lumber. Farmer opinion related to resource-readiness for saw-timber is worth noting. Asked, "when would you use this tree for furniture wood?", farmers frequently responded "when the tree is large, like this…" at which point the farmer would hold this arms in front of himself to form a circle, as if he was wrapping his arms around a tree trunk to measure it. This designation may not appear to be very exact, but it indicates farmer preference of using trees with large diameter trunks as saw timber for furniture uses and smaller diameter trunks as pole timber for construction purposes, as mentioned earlier.

<u>Posts</u>

Clearly defined property boundaries are often established through the incorporation of woody or non-woody species in areas of high population like Las Huertas (Raintree and Warner 1986). In Las Huertas, farmers used fence posts, barbed wire and thorny plants to deter any would be trespassing person or animal. Typically, a straight portion of trunk or branch set in the ground with barbed-wire strung between the posts and a spiny, tough relative of the pineapple (*Bromelia pinquin*) was usually planted below the barbed wire. A similar arrangement of materials has been noted throughout Central America (Sauer 1979)[6].

Fence posts were established in Las Huertas as live-fences, yielding additional products, and the cutting of other fence posts. Twenty-six households reported species useful as fence posts. *Mimosa tenuiflora* and *Cordia dentata* were most commonly recommended, 15 and 10 farmers, respectively. *Mimosa tenuiflora* was reportedly used at any time of the year. All households reported that this species, although sometimes placed in the ground, would never take root and become a live fence post. In contrast, straight *Cordia dentata* branches about 15cm in diameter, were specifically cut in late April and set about 50cm into the ground. These branches would then resprout and grow once the rains came in May and as a living fence post became a source of fruit, fuelwood, shade, construction materials, medicinal plants, and other fence posts for the household (Daugherty 1970).

Tenure restrictions did not apply to post uses (Table 5), primarily because the management activities associated with posts were not completely removing the tree from the field. Once again, only straight branches, perhaps those shading crops or those cut for fodder use were employed for this purpose. All the species mentioned by farmers are commonly used elsewhere in Central America (Radulovich *et al.* 1994).

Tool Wood

Farmer opinion was unanimous that small diameter, yet hard branches of *Tabebuia impetiginosa*, *Chlorophora tinctoria*, *Psidium guava*, *Luehea candida*,

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[6] The authors' personal observations of this boundary system have been made in parts of Guatemala and Honduras, as well as El Salvador.

Cresentia alata, and *Cordia alliodora* should be used for tool handle purposes such as for a curved machete, planting stick, or hoe. Smaller portions of a branch were actually needed to manufacture a handle and renter farmers had open access to trees for tool handle wood use (Table 4 and 5). However, larger tool wood use was, in general, restricted by tenure and access limitations (Table 4 and 5), which illustrates that the recognized importance of these species in the farmer knowledge base is separate from tenure.

Several species were specifically labeled by eight farmers (18 %) as excellent for the preparation of the axle for wooden wagons. In each case, "wagon axle" was the utility designated for the four high specific gravity species which were *Karwinskia calderoni calderonii*, *Chlorophora tinctoria*, *Caesalpinia coriaria*, and *Lonchocarpus minimiflorus* (Appendix C). Use of carts in agricultural areas is very common and Jambulingam and Fernandes (1986) reported that farmers in Tamil Nadu, India were also familiar with cart construction uses of *Acacia nilotica*. In Las Huertas the task of manufacturing an axle was not as common as the knowledge concerning appropriate species. Key informant farmers stated that the only place to get a wagon made was in the next village, about 3 km away.

<u>Shade</u>

Farmers identified species for shade use by both humans and animals. Almost an equal number of farmers (12 and 13, respectively) stated that shade use was for animals or humans. Four species, *Enterolobium cyclocarpum*, *Pithecellobium saman*, *Cordia dentata*, and *Guazuma ulmifolia* were identified as useful to animals and provided fallen fruits for fodder at the end of the dry-season. Thirteen farmers reported that humans are the primary users of shade trees for resting from field work. This same use was commonly reported as of value to traditional farmers in Sri Lanka who primarily planted trees on rice paddy bunds to provide a resting area for small children brought to field while their parents work and for the entire family in meals times (Ulluwishewa 1991).

Renter farmers, in general, stated that they had open access during working hours to shade use (Table 4 and 5). This open access to shade use may be the reason why 10 renter farmers identified this as the primary use for the dispersed trees on their rented fields. These same species were identified by other farmers for other purposes, and specification of this use may indicate renter farmer prioritization of use according to accessibility, with shade being very accessible and therefore a high priority.

Other

Some residents in Las Huertas recommended the oil, pressed and processed from *Simarouba glauca* fruits, as an excellent source of soap for general and hygienic purposes. Armour (1959) has reviewed the potential of *Simarouba glauca* as an oil-nut producing tree and recommended using vegetative methods for propagation. Two farmers stated that *Ceiba pentandra* is very useful as a boat and one farmer recommended using the fluffy endocarp of the opened seed pods as stuffing for a mattress or pillow. The usefulness of *Ceiba pentandra* as stuffing was also popular in India, and Jambulingam and Fernandes (1986) reported that Indian farmers in Tamil Nadu use *Ceiba pentandra* for the same purposes. Two other farmers stated that *Gliricidia sepium* and *Mimosa tenuiflora* could be used for organic pesticide preparation and black-smith furnace fires, respectively. One farmer stated that tannins extracted from *Caesalpinia coriaria* fruits can be used for tanning leather hides. This use has been known for many years and was mentioned by Calderon and Standley (1941) in one of the earliest reference books for Salvadoran plants and trees.

Two households specified several uses which had religious significance. Both households mentioned that *Spondias purpurea* fruits were used for preparation of molasses ("miel") during Holy Week. Also, several key informant households described the significance of the cross shaped *Cresentia alata* leaves, and stated that branches were carried to church on Day of The Cross to be blessed. These branches were then placed at the four corners of the house to pass the blessing on to the house and household[7].

[7]Other areas of El Salvador celebrate Day of the Cross by standing jiote (*Bursera simaruba*) branches, arranged in the shape of a cross, in the ground and pouring water over the cross on May 3rd, Day of the Cross to ensure the arrival of early rains. Often the branch in contact with the ground will take root and grow and become a tree, this was observed in several communities.

Chapter 6

CONCLUSION

6.1 Limitations of this Study and Future Research

Limitations

In an attempt to survey and dialogue with the person actually responsible for retaining a tree within a field, the decision was made to speak with the principal producer of the staple field crops. Adherence to this parameter yielded a population census of Las Huertas that was comprised of five women and 38 men. However, the extrapolation or inference of gender tendencies within this population was not possible due to the unbalanced gender distribution of five women and 38 men. Obviously, there were more men as the primary staple crops producer in Las Huertas. However, this obscures the fact that women are involved in basic grains production at various levels. Even though women were present and participated in over half of the interviews conducted, it is not however, possible to infer that their gender is accurately represented in the information or results.

Future Research

Knowledge of local "resource readiness" classification systems could be very useful in understanding dispersed tree utilization. When, these resources are used or when they move from one use size to the next (i.e. pole timber to saw timber) could benefit planners and communities in setting appropriate project goals. For example, because farmers prefer *Cordia alliodora* for pole timbers, there could be potential problems if a project was promoting this species for saw timber.

The information gathered revealed that farmers were concerned about the amount of shade their crops received from some dispersed tree species. This indicates that there is an understanding of tree-crop interactions. Positive and negative crop and tree interactions need to receive further research considerations and local indigenous knowledge can provide necessary insights to guide the research and development process.

6.2 Conclusions and Recommendations

Conclusions

Farming communities utilize wood and non-wood tree resources for a wide variety of purposes. Farmers in Las Huertas retained and managed trees in dispersed patterns within agricultural fields to serve as important sources of useful materials for household needs. Certain species were managed to provide specific benefits and were selectively protected and favored by these farmers to enable them to utilize these trees in the future.

Farmers have developed management practices which allow them to utilize their dispersed trees as multiple purpose tree or one-time use. Certain species such as *Enterolobium cyclocarpum*, *Guazuma ulmifolia*, and *Simarouba glauca* were managed to provide multiple purposes such as such fodder, fruit, shade, medicine, tool wood, posts, and fuelwood. While other species such as *Cordia alliodora*, *Cordia dentata*, *Karwinskia calderoni calderonii*, *Lysiloma divarticatum*, and *Mimosa tenuiflora* were managed to provide one-time uses such as construction wood. One-time use however, did not exclude other post-harvest uses of the dispersed tree residues. For example, removing a tree for construction purposes released the fuelwood resource previously unavailable.

Farmers who fed a combination of tree fodder and crop residues to their cows during the dry season reported that milk production rates were only 5 % lower than wet season rates. In contrast, farmers in Las Huertas who used only crop residues reported milk production rates that were 60 % less than during the wet season. In this way dispersed trees were important in meeting farmers needs at critical times of the year.

Farmers who anticipated house and out-building construction in Las Huertas depended greatly on the dispersed trees resources growing within their fields. Over 25 % of all tree use assignments and 27 dispersed tree species were for construction uses. Even specific locations were identified within a house for certain types of wood products such as corner-posts, rafters, cross-beams, inner wall supports, and tile supports.

Access and use of dispersed tree resources was strongly influenced by land tenure rights. Primarily, any use that would imply the removal of the tree itself, was not permissible under the tenancy rights system. However, even under these restrictions, it was possible for renter farmers to utilize fallow vegetation from parcels they rent. This agreement was for parcels that were brought into production that year and farmers must remove the dried materials before or during the harvest period.

Recommendations

The results of this study indicated that the women and men of Las Huertas were very familiar with their natural surroundings and have developed their agroforestry adaptations based upon this understanding. For this reason it is recommended that future agroforestry projects in rural areas of El Salvador, Central America, and other developing countries investigate local indigenous knowledge as part of the planning process. Leadership in this role had been provided by the initiation of farmer managed experiments in Central America (Belaunde and Rivas 1993). All these activities should be done in as participatory manner with community members contributing their knowledge and experience to guide the project.

Concurrent with this local knowledge investigation it is imperative to gain understanding concerning local land tenure and tree tenure issues. The relationship between renter and owner farmers in many areas of the world follows specific rules which require time to fully comprehend. For example, it could be possible that certain user rights are only in place during a particular time of the year. Participatory research processes can aid in gathering this information to avoid pitfalls and problems in designing agroforestry interventions.

Finally, at the resource poor farmer household level, preservation and active engagement of local knowledge regarding agroforestry tree species is critical to project success. Because community opinion regarding the dispersed trees to retain or establish in the fields may be distinct from species recommendations completed by an agency or development effort from outside of the community. Thus, one author states that "selection of agroforestry components and extension technologies should begin with systematic assessment of existing practices" (Scherr 1995:802). Promotion of unfamiliar tree species may result in disillusioned beneficiaries and frustrated agency personnel. Global transfer of multiple purpose tree germplasm is very easily done. However, the indigenous knowledge associated with these multiple purposes is often not transferred and the usefulness of the introduced species may be diminished (Mathias-Mundy *et al.* 1992).

Highly populated rural agrarian areas with limited forest resources presently utilize locally known tree and shrub species in agroforestry systems. How these communities will continue to benefit from their resources depends on many interrelated and dynamic factors. A disruption of farming system efficiency is often caused by increased demands on a diminishing land resource, increased population, shifts from self-sufficient agriculture to cash-crop, increased dependence on off-farm resources such as fertilizers, hybrid seeds, pesticides, and colonization of areas unfavorable to farming methods familiar to the migrant population. During migration to new areas or relocation of youth populations to urban areas, the local ethno-botanical knowledge carried within a community may be lost. The dispersed tree indigenous knowledge in Las Huertas is an example of a community knowledge that, if understood and engaged in a participatory way, can guide and direct agroforestry interventions in positive and fruitful ways.

APPENDICES

APPENDIX A

Appendix A Plate 1

Cordia alliodora

Landscape of dispersed trees in Las Huertas, El Salvador. *Cordia alliodora* and watermelon/bean field in foreground, maize and sorghum fields in background with more *Cordia alliodora* and *Simarouba glauca*. San Miquel Volcano (Chaparrastique) is in the distance.

Appendix A Plate 2

Simarouba glauca

Simarouba glauca and watermelon/bean field. Note the dense full canopy of the tree and the amount of shade cast on the cultivated crops. There is typically not many of these trees on the fields.

Appendix A Plate 3

Guazuma ulmifolia

Guazuma ulmifolia as a dispersed tree in a maize field in Las Huertas, El Salvador. The foliage of this tree serves as an excellent tree fodder and the removed branches are commonly used as fuelwood.

Appendix A Plate 4

Mimosa tenuiflora

Mimosa tenuiflora vegetation in a fallow/pasture area that was cleared for agricultural production in June 1996. The foliage will dry in the field and contribute leaf litter to the soil. Note the multiple, straight stems which serve well as firewood, construction materials for walls and roofs, and posts.

APPENDIX B

Appendix B Table 1

Dispersed tree species most commonly found (> 10 % frequency) in farmers fields in Las Huertas, El Salvador, June to August, 1996 by botanical and local tree name and the percentage of fields in which they were present.[1]

Scientific name	Local name	Percentage of fields where species occurred[2]
Cordia alliodora	laurel	30 %
Mimosa tenuifolia	carbón	29 %
Guazuma ulmifolia	guacimo	29 %
Simarouba glauca	aceituno	27 %
Enterolobium cyclocarpum	guanacaste negro	18 %
Cordia dentata	tigüilote	17 %
Karwinskia calderoni calderonii	guiliguiste	12 %
Lysiloma divarticatum	quebracho	12 %

[1] During the interview process, 66 fields were visited and the number of dispersed trees recorded for each field.

[2] Tree species which were recorded on more than 10 % of the visited fields (n = 66).

Appendix B Table 2

Dispersed tree species less commonly found (< 10 % frequency) in farmers fields in Las Huertas, El Salvador, June to August, 1996 by botanical and local tree name and the percentage of fields in which they were present.[1]

Scientific name	Local name	Percentage of fields where species occurred[2]
Albizia caribea	guanacaste blanco	9 %
Anacardium occidentale	marañon	9 %
Cresentia cujete	jicaro	9 %
Caesalpinia coriaria	nacascolo	7.5 %
Gliricidia sepium	madre de cacao	6 %
Brysonima crassifolia	nance	6 %
Chlorophora tinctoria	mora	6 %
Calycophyllum candidissimum	salamo	6 %
Ceiba pentandra	ceiba	6 %
Alvaradoa amorphoides	zorro	4.5 %
Andira inermis	almendro	4.5 %
Anona reticulata	anona	4.5 %
Bursera simaruba	jiote	4.5 %
Genipa americana	jagua	4.5 %
Mangifera indica	mango	4.5 %
Mimosa platycarpa	carboncillo	4.5 %
Acacia pennatula [3]		
Pithecellobium saman	carreto	4.5 %
Tabebuia impetiginosa	cortez	4.5 %
Thounidium decandrum	zorillo	4.5 %
unknown	zorro candelio	4.5 %
Acacia farnesiana	espino blanco	3 %
Casearia corymbosa	come culebra	3 %
Cassia grandis	carao	3 %
Cresentia alata	morro	3 %
Eucalyptus sps.	Eucalyptus	3 %
Lonchocarpus minimiflorus	chaperno	3 %
Psidium guava	guayaba	3 %
Spondias purpurea	jocote	3 %
Stemmadenia obovata	cojón	3 %
Astroneum graveolens	ron-ron	1.5 %

Appendix B Table 2 (cont'd)

Scientific name	Local name	Percentage of fields where species occurred[2]
Combretum farinosum	chupa-chupa	1.5 %
Exostema caribaeum	quina	1.5 %
Haematoxylon campechianum	brasil	1.5 %
Hymanea courbaril	guapinol	1.5 %
Luehea candida	cabo de acha	1.5 %
Piptadenia constricta	pintadillo	1.5 %
Piscida carthagenensis	zope	1.5 %
Pithecellobium dulce	mangoyano	1.5 %
Richardia scabra	tabaquillo	1.5 %
Spondias mombin	jocote agrio	1.5 %
Swietenia humilis	caoba	1.5 %
Tabebuia rosea	maquiliste	1.5 %
unknown	caguano	1.5 %
unknown	san cristóbal	1.5 %

[1] During the interview process, 66 fields were visited and the number of dispersed trees recorded for each field.

[2] Tree species which were recorded on less than 10 % of the visited fields (n = 66).

[3] There was some confusion on correct name for this tree species. Both scientific names were given in the same reference for this common name (Medina *et al.* 1994). *Mimosa platycarpa* was used in the text exclusively.

APPENDIX C

Appendix C

Specific gravity measurements for several dispersed tree species found in farmers fields in Las Huertas, El Salvador .

	specific gravity (ovendry weight/green volume)
Calycophyllum candidissimum	0.67 [a]
Cholorophora tinctoria	0.71-0.78 [a]
Cordia alliodora	0.44-0.52 [a]
Gliricidium sepium	0.855 [b]
Hymanaea courbaril	0.7-1.06 [b]
Karwinskia calderoni calderonii	1.05-1.2 [b]
Lysiloma divarticatum	0.63 [a]

[a] Chudnoff, Martin 1980. *Tropical Timbers of the World. Agriculture Handbook 607.* Unites States Department of Agriculture, Forest Service, Washington, D.C.

[b] Witsberger, Dennis, Dean Current, and Edgar Archer 1981. *Arboles del Parque Deininger.* Ministerio de Educaci6n, San Salvador, El Salvador.

APPENDIX D

Appendix D Table 1

Botanical and local tree species names and uses of the dispersed trees found in farmers fields in Las Huertas, El Salvador [a].

Scientific name	Local name	Use [b] First [c]	Second [c]	Third [c]
Acacia farnesiana	espino blanco	F, P	F	
Albizia caribea	guanacaste blanco	C, F, N, S	F	
Alvaradoa amorphoides	zorro	C, F, S	F	
Anacardium occidentale	marañon	T	T	F
Andira inermis	almendro	S		
Anona reticulata	anona	T		
Astroneum graveolens	ron-ron	S		
Brysonima crassifolia	nance	F, S, T	S	F
Bursera simaruba	jiote	N, P		
Caesalpinia coriaria	nacascolo	C, L, O	C, D, L, P	C, S
Calycophyllum candidissimum	salamo	C	F	
Casearia corymbosa	come culebra	C, S	F	
Cassia grandis	carao	C, D	P	F
Ceiba pentandra	ceiba	C, L, O	N, O	O
Chlorophora tinctoria	mora	L	C, N, S	
Combretum farinosum	chupa-chupa	G		
Cordia alliodora	laurel	C, S	C, F, L, N	F, N
Cordia dentata	tigüilote	C, P	C, D, F, P, S	C, D, F, S
Cresentia alata	morro	T	L	
Cresentia cujete	jicaro	S, T	L, M	
Enterolobium cyclocarpum	guanacaste negro	C, S	C, D, F, N, S	D, S
Eucalyptus sps.	Eucalyptus	C	M	
Exostema caribaeum	quina	M		
Genipa americana	jagua	M, S, T		
Gliricidia sepium	madre de cacao	C, D, P	C, F, O	D
Guazuma ulmifolia	guacimo	D, F, G, M, S, T	C, D, F, M, P, S	C, F, M, P, S
Haematoxylon campechianum	brasil	M	F	

Appendix D Table 1 (cont'd)

Scientific name	Local name	Use[b] First[c]	Use[b] Second[c]	Use[b] Third[c]
Hymanea courbaril	guapinol	N		
Karwinskia calderoni calderonii	guiliguiste	C, P, S	C, F, L	
Lonchocarpus minimiflorus	chaperno	C, L	C, P	F
Luehea candida	cabo de acha	L		
Lysiloma divarticatum	quebracho	C	D, F	P
Mangifera indica	mango	T	C, S	S
Mimosa platycarpa Acacia pennatula	carboncillo	F, P	P	
Mimosa tenuifolia	carbón	C, F, P	C, F, P	D, F
Piptadenia constricta	pintadillo	F	C	
Piscida carthagenensis	zope	F		
Pithecellobium dulce	mangoyano	F		
Pithecellobium saman	carreto	C	D, F	S
Psidium guava	guayaba	T	L	
Richardia scabra	tabaquillo	F		
Simarouba glauca	aceituno	C, N, T	C, N, S, T	F, C, O
Spondias mombin	jocote agrio	P		
Spondias purpurea	jocote	T	T	
Stemmadenia obovata	cojón	F	P	
Swietenia humilis	caoba	N	F	
Tabebuia impetiginosa	cortez	C, F, L	C, L	
Tabebuia rosea	maquiliste	C		
Thounidium decandrum	zorillo	C, S	F	
unknown	caguano	N		
unknown	san cristóbal	C		
unknown	zorro candelio	C	F	

[a] Sorted alphabetically by botanical name.

[b] Uses: C = construction wood; D = fodder; F = fuelwood; G = nothing; L = tool wood; M = medicine; N = furniture wood; O = other; P = posts; S = shade; T = fruit.

[c] Particular uses of tree species ranked by farmers (alphabetical order).

Appendix D Table 2

Local and botanical tree species names and uses of the dispersed trees found in farmers fields in Las Huertas, El Salvador [a].

Local name	Scientific name	Use [b] First [c]	Use [b] Second [c]	Use [b] Third [c]
aceituno	*Simarouba glauca*	C, N, T	C, N, S, T	F, C, O
almendro	*Andira inermis*	S		
anona	*Anona reticulata*	T		
brasil	*Haematoxylon campechianum*	M	F	
cabo de acha	*Luehea candida*	L		
caguano	unknown	N		
caoba	*Swietenia humilis*	N	F	
carao	*Cassia grandis*	C, D	P	F
carboncillo	*Mimosa platycarpa* *Acacia pennatula*	F, P	P	
carbón	*Mimosa tenuifolia*	C, F, P	C, F, P	D, F
carreto	*Pithecellobium saman*	C	D, F	S
ceiba	*Ceiba pentandra*	C, L, O	N, O	O
chaperno	*Lonchocarpus minimiflorus*	C, L	C, P	F
chupa-chupa	*Combretum farinosum*	G		
cojón	*Stemmadenia obovata*	F	P	
come culebra	*Casearia corymbosa*	C, S	F	
cortez	*Tabebuia impetiginosa*	C, F, L	C, L	
espino blanco	*Acacia farnesiana*	F, P	F	
eucalyptus	*Eucalyptus* sps.	C	M	
guacimo	*Guazuma ulmifolia*	D, F, G, M, S, T	C, D, F, M, P, S	C, F, M, P, S
guanacaste blanco	*Albizia caribea*	C, F, N, S	F	
guanacaste negro	*Enterolobium cyclocarpum*	C, S	C, D, F, N, S	D, S
guapinol	*Hymanea courbaril*	N		
guayaba	*Psidium guava*	T	L	
guiliguiste	*Karwinskia calderoni calderonii*	C, P, S	C, F, L	
jagua	*Genipa americana*	M, S, T		
jicaro	*Cresentia cujete*	S, T	L, M	
jiote	*Bursera simaruba*	N, P		

Appendix D Table 2 (cont'd)

Local name	Scientific name	Use [b]		
		First [c]	Second [c]	Third [c]
jocote	*Spondias purpurea*	T	T	
jocote agrio	*Spondias mombin*	P		
laurel	*Cordia alliodora*	C, S	C, F, L, N	F, N
madre de cacao	*Gliricidia sepium*	C, D, P	C, F, O	D
mango	*Mangifera indica*	T	C, S	S
mangoyano	*Pithecellobium dulce*	F		
maquiliste	*Tabebuia rosea*	C		
marañon	*Anacardium occidentale*	T	T	F
mora	*Chlorophora tinctoria*	L	C, N, S	
morro	*Cresentia alata*	T	L	
nacascolo	*Caesalpinia coriaria*	C, L, O	C, D, L, P	C, S
nance	*Brysonima crassifolia*	F, S, T	S	F
pintadillo	*Piptadenia constricta*	F	C	
quebracho	*Lysiloma divarticatum*	C	D, F	P
quina	*Exostema caribaeum*	M		
ron-ron	*Astroneum graveolens*	S		
salamo	*Calycophyllum candidissimum*	C	F	
san cristóbal	unknown	C		
tabaquillo	*Richardia scabra*	F		
tigüilote	*Cordia dentata*	C, P	C, D, F, P, S	C, D, F, S
zope	*Piscida carthagenensis*	F		
zorillo	*Thounidium decandrum*	C, S	F	
zorro	*Alvaradoa amorphoides*	C, F, S	F	
zorro candelio	unknown	C	F	

[a] Sorted alphabetically by local name.

[b] Uses: C = construction wood; D = fodder; F = fuelwood; G = nothing; L = tool wood; M = medicine; N = furniture wood; O = other; P = posts; S = shade; T = fruit.

[c] Particular uses of tree species ranked by farmers (alphabetical order).

APPENDIX E

Appendix E Table 1

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for FODDER for meat and milk production by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Caesalpinia coriaria			1	6		
Cassia grandis	1	1				
Cordia dentata			2	78	1	1
Enterolobium cyclocarpum			3	21	2	4
Gliricidia sepium	1	5			1	9
Guazuma ulmifolia	1	14	2	7		
Lysiloma divarticatum			1	2		
Mimosa tenuifolia					1	n.a.
Pithecellobium saman			2	2		

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 2

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for FUELWOOD by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Acacia farnesiana	1	1	1	2		
Albizia caribea	2	2	4	7		
Alvaradoa amorphoides	1	2	1	3		
Anacardium occidentale					1	34
Brysonima crassifolia	1	1			1	1
Calycophyllum candidissimum			3	3		
Casearia corymbosa			2	3		
Cassia grandis					1	1
Cordia alliodora			4	98	4	149
Cordia dentata			2	3	1	4
Enterolobium cyclocarpum			1	55		
Gliricidia sepium			1	5		
Guazuma ulmifolia	5	13	4	14	2	5
Haematoxylon campechianum			1	1		
Karwinskia calderoni calderonii			2	11		
Lonchocarpus minimiflorus					1	2
Lysiloma divarticatum			7	36		
Mimosa platycarpa	2	5				
Acacia pennatula						
Mimosa tenuifolia	4	11	7	157	3	224
Piptadenia constricta	1	7				
Piscida carthagenensis	1	1				
Pithecellobium dulce	1	1				
Pithecellobium saman			1	5		
Richardia scabra	1	1				
Simarouba glauca					1	3
Stemmadenia obovata	2	3				
Swietenia humilis			1	1		
Tabebuia impetiginosa	1	3				
Thounidium decandrum			1	6		
zorro candelio			2	3		

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 3

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for FRUIT by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Anacardium occidentale	6	40	6	40		
Anona reticulata	3	3				
Brysonima crassifolia	2	6				
Cresentia alata	2	3				
Cresentia cujete	3	5				
Genipa americana	1	1				
Guazuma ulmifolia	1	3				
Mangifera indica	3	9				
Psidium guava	2	5				
Simarouba glauca	4	9	7	8	1	1
Spondias purpurea	2	7	1	1		

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 4

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for MEDICINE by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Cresentia cujete			1	3		
Eucalyptus sps.			1	1		
Exostema caribaeum	1	1				
Genipa americana	1	1				
Guazuma ulmifolia	2	7	2	6	1	6
Haematoxylon campechianum	1	1				

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 5

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for CONSTRUCTION by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Albizia caribea	1	1				
Alvaradoa amorphoides	1	3				
Caesalpinia coriaria	2	7	1	1	1	3
Calycophyllum candidissimum	4	4				
Casearia corymbosa	1	1				
Cassia grandis	1	1				
Ceiba pentandra	2	2				
Chlorophora tinctoria			2	2		
Cordia alliodora	18	290	1	2		
Cordia dentata	3	4	2	8	1	4
Enterolobium cyclocarpum	11	92	1	1		
Eucalyptus sps.	2	6				
Gliricidia sepium	2	2	1	9		
Guazuma ulmifolia	1	3	1	3		
Karwinskia calderoni calderonii	6	17	1	3		
Lonchocarpus minimiflorus	1	2	1	1		
Lysiloma divarticatum	8	38				
Mangifera indica	1	7				
Mimosa tenuifolia	3	321	2	30		
Piptadenia constricta	1	7				
Pithecellobium saman	3	7				
Simarouba glauca	7	16	3	11	2	3
Tabebuia impetiginosa	1	1	1	1		
Tabebuia rosea	1	1				
san cristobal	1	12				
zorro candelio	3	4				

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 6

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for FURNITURE by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Bursera simaruba	1	1				
Ceiba pentandra			1	1		
Chlorophora tinctoria			1	1		
Cordia alliodora			7	164	1	2
Enterolobium cyclocarpum	1	4	1	1		
Hymanea courbaril	1	1				
Simarouba glauca	4	11	3	6		
Swietenia humilis	1	1				
caguano	1	1				

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 7

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for POSTS by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Acacia farnesiana	1	2				
Bursera simaruba	2	3				
Caesalpinia coriaria			1	3		
Cassia grandis			1	1		
Cordia dentata	8	94	2	3		
Gliricidia sepium	1	9				
Guazuma ulmifolia			1	1	1	2
Karwinskia calderoni calderonii	1	3				
Lonchocarpus minimiflorus			1	2		
Lysiloma divarticatum					2	15
Mimosa platycarpa Acacia pennatula	1	1	1	4		
Mimosa tenuifolia	9	187	6	329		
Spondias mombin	1	1				
Stemmadenia obovata			1	2		

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 8

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for TOOL WOOD by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Caesalpinia coriaria	2	4	2	2		
Ceiba pentandra	1	1				
Chlorophora tinctoria	4	4				
Cordia alliodora			3	18		
Cresentia alata			1	1		
Karwinskia calderoni calderonii			4	6		
Lonchocarpus minimiflorus	1	1				
Luehea candida	1	1				
Psidium guava			1	2		
Tabebuia impetiginosa	1	1	1	3		

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 9

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for SHADE by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Albizia caribea	2	2				
Alvaradoa amorphoides	1	2				
Andira inermis	2	2				
Astroneum graveolens	1	1				
Brysonima crassifolia	1	1	1	1		
Caesalpinia coriaria					1	1
Casearia corymbosa	1	2				
Chlorophora tinctoria			1	1		
Cordia alliodora	1	2				
Cordia dentata			1	1	1	20
Cresentia cujete	1	1				
Enterolobium cyclocarpum	1	1	1	3	1	18
Genipa americana	1	1				
Guazuma ulmifolia	6	14	2	7	1	3
Karwinskia calderoni calderonii	1	1				
Mangifera indica			1	1	1	7
Pithecellobium saman					1	1
Simarouba glauca	1	6	2	2		
Thounidium decandrum	2	2				

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

Appendix E Table 10

Dispersed tree species found on farmers fields in Las Huertas, El Salvador identified as being used for other UNIQUE USES by the number of farmers who identified each particular species listed and the number of trees ranked by importance of this use.

Scientific name	Number of farmers and trees [a]					
	First Use [b]		Second Use [b]		Third Use [b]	
	farmer	trees	farmer	trees	farmer	trees
Caesalpinia coriaria	1	1				
Ceiba pentandra	1	1	1	1	1	1
Gliricidia sepium			1	1		
Mimosa tenuifolia					1	6
Simarouba glauca	1	4	2	4	2	3

[a] Number of farmers (n = 43), number of tree species (n=52).

[b] Number of farmers who identified a species with this use and the number of trees that farmers assigned this use. In each field, the farmer was asked to identify all uses for that species and then rank them according to importance of use.

APPENDIX F

Appendix F

Fruit trees found in homegardens in Las Huertas, El Salvador and the percentage of households which were growing each species.

Scientific name	Common name	Percentage of households
Spondias purpurea	jocote	48.8 % (21)
Anacardium occidentale	marañón	39.5 % (17)
Mangifera indica	mango	35 % (15)
Citrus spp.	citrus	35 % (15)
Carica papaya	papaya	32.6 % (14)
Tamarindus indica	tamarindo	16.3 % (7)
Andira inermis	almendro	7 % (3)
Persea americana	aguacate	4.6 % (2)
Anona reticulata	anona	4.6 % (2)
Brysonima crassifolia	nance	2.3 % (1)
Musa spp.	guineo	2.3 % (1)
Cresentia cujete	jicaro	2.3 % (1)
Cresentia alata	morro	2.3 % (1)
Cocos nucifera	coco	2.3 % (1)
Meliccoca bijuga	mamones	2.3 % (1)

[a] Number of households (n = 43).

APPENDIX G

Appendix G

Household Information Survey Guide

Agroforestry of Dispersed Trees **HH# _______**

Instructions : After reading the declaration of participation on the front page, and after greetings and salutations, ask the following questions to the head of the household.

---

1. **Are you from this village? If yes,**
2. **Have you lived here all your life?**
3. **How many people live in this house?**
4. **How old are you?**
5. **How many years did you go to school?**
6. **Have you ever participated in an agroforestry project? If yes,**
7. **Was there a part that had to do with trees?**
8. **Do you have pastures? If yes,**
9. **What is the area?**
10. **Are these owned or rented?**
11. **Do you have cereal fields? If yes,**
12. **What is the area?**
13. **Are these fields owned or rented?**
14. **Do you have fruit trees? If yes,**
15. **Where?**

16. Who planted these trees?

17. What animals do you have? If yes,

18. How many of them do you have?

19. Have you sold any since last summer? If yes,

20. Which ones did you sell?

21. How many did you sell?

22. Why did you sell them?

23. Where did you sell them?

24. In what month did you sell them?

25. What do you feed your animals in the winter?

26. Which tree fodder?

27. What fodder do you use in the summer?

28. Where does your tree fodder grow?

29. Where does the majority of your tree fodder grow?

30. How many cows do you milk a day?

31. How many times per day?

32. Do your calves milk also?

33. How many bottles do you produce per day in the winter?

34. Does this number go down in the summer? If yes,

35. How many bottles do you produce in the summer?

36. What milk products do you make at home?

37. Does the quantity of your milk products also drop-off in the summer? If yes,

38. Who eats these milk products?

39. Have you sold and milk products during the last year? If yes,

40. Where did you sell them?

41. When did you sell them?

42. How many tree are there in each field?

Agroforestry of Dispersed Trees **HH#_____**

1	from here		
2	life		
3	persons		
4	age		
5	grade		
6	program		
7	trees		
8	pasture		
9	areas		
10	own/rent		
11	grains		
12	areas		
13	own/rent		
14	fruits		
15	where		
16	planted		
17	animals		
18	how many		
19	sold any		
20	which ones		
21	how many		
22	why		
23	where		

24	when		
25	winter		
26	fodder		
27	summer		
28	where		
29	most		
30	cows		
31	times		
32	calves		
33	bottles		
34	down milk		
35	summer		
36	products		
37	down		
38	who eats		
39	sold		
40	where		
41	when		
42	how many		

Agroforestry of Dispersed Trees **HH# ______**

Tree: *refers to woody plants: shrubs or trees*

Instructions: *draw the farm map, finish the household questionnaire, ask if it is possible to see some dispersed trees, and then* ***ask the following questions for every species of dispersed tree.***

---

1. What is the **name** of this tree?

2. **Where** is the tree located?

3. Is this plant a **shrub** or a **tree**?

If this tree *is in a* ***pasture,***

4. What is the **name of the pasture grass**? (circle response(s))

5. How many cows **graze** on this pasture right now? ________________

If this tree *is in a* ***crop field,***

6. What **crop** is this **growing right now** in this field?

7. What was the **total production in quintals** for this field last primera and postera?

Ask: What are ***all the uses*** *of this tree?*

____

____

____

____

8. Of **all** the things provided, what is the **most valued use** of this tree?

9. You said ______________ was the **most valued use** of this tree. What **months do you use** the tree for _____________?

10. What **parts** of the tree do you use for ________________ ?

11. What **do you do to** the tree to get the ________________ ?

12. **Who** comes to get the ______________ from the tree?

13. What is the **second most valued use** of this tree?

14. You said ______________ was the second **most valued use** of this tree. What **months do you use** the tree for _____________?

15. What **parts** of the tree do you use for ________________ ?

16. What **do you do to** the tree to get the ________________ ?

17. **Who** comes to get the ______________ from the tree?

18. What is the **third most valued use** of this tree?

19. You said ______________ was the third **most valued use** of this tree. What **months do you use** the tree for _____________?

20. What **parts** of the tree do you use for ________________ ?

21. What **do you do to** the tree to get the ________________ ?

22. **Who** comes to get the ______________ from the tree?

23. Is this **land rented or owned**?

<u>If rented</u>:

24. You said ______________ was the most valued use of this tree, is your **use of this tree for** _____________ ever **limited**?

25. **<u>If Yes</u>**, what months is the use for these products limited?

26. You said ______________ was the second most valued use of this tree, is your **use of this tree for** _____________ ever **limited**?

27. **<u>If Yes</u>**, what months is the use for these products limited?

28. You said ______________ was the third most valued use of this tree, is your **use of this tree for** _____________ ever **limited**?

29. **<u>If Yes</u>**, what months is the use for these products limited?

We've talked about the uses of the tree, let's talk about establishing this kind of tree.

30. **Who planted** this tree?

If someone planted it,

31. Can you remember **what year** you planted this tree? ______________

32. If you did not plant it, or cannot remember exactly when it was planted, **how old** do you think this tree is now? ______________

Getting back to planting the tree,

33. **How did** you plant it?

If you planted this tree as a stake:

34. What is **the shape** of the cutting at the **top & bottom**?

35. **When** do you **take cuttings** for stakes?

36. How **many days** do you let these stakes **rest before you plant them**?

37. Out of 10 trees planted as stakes, how many will **survive**? __________

*What did you do to **ensure the survival** of this tree:*

38. When it was **just planted**?

39. When it was **young and growing**?

40. What **conditions are important** (weather, etc.) when you plant stakes?

____

____

____

41. Do you **plant** according to the **moon phase**?

42. If **YES, which phase**?

43. When you plan, where do you generally get the stakes you need?

*We've talked about the **important benefits** that this tree has for you and your animals,*

44. What are **all the negative aspects**, or the things you like the least about this tree?

____

____

____

____

45. What **do you do** to correct for this problem?

That's all the questions I have about this tree. I'd like to take some measurements of it, but before I do that, is there anything else you think I should know about this tree and it's uses?

____

____

____

____

46. What is the **dbh** of this tree? ______________

47. What is the **height** of this tree? ___________

48. What is the **crown diameter**? #1 ____ #2 ____ #3 ____ #4 ___ Average _______

May I take a **picture** of the tree?

May I **draw a map** of the location of each tree?

1	name		
2	tree/shrub		
3	where		
4	pasture		
5	# of cows		
6	crop		
7	production		
8	first		
9	when		
10	what		
11	how		
12	who		
13	second		
14	when		
15	what		
16	how		
17	who		
18	third		
19	when		
20	what		
21	how		
22	who		
23	own/rent		

24	first pro		
25	when		
26	second pro		
27	when		
28	third pro		
29	when		
30	planted		
31	year		
32	old		
33	how		
34	when cut		
35	days wait		
36	survival		
37	phases		
38	which		
39	recent		
40	growing		
41	stakes		
42	seedlings		
43	not like		
44	correct		
45	dbh		
46	height		
47	diameter		

Agroforestería de Arboles en Disperso *HH#____*

Instrucciones: *Despues de leer la declaración de participación en la primera página, y despues de presentaciones y saludos, preguntale las siguientes preguntas al miembro de la casa encargada de la casa*

I. Información de la casa

1. Ud. es de este pueblo?

    1=Sí 2=No

2. Ha vivido Ud. aquí toda su vida?

    1=Sí 2=No

3. Cuántas personas viven en la casa? ________

4. Cuántos años tiene Ud.? ________

5. Hasta qué grado llego? ________

6. Ha participado Ud. en un programa de extensión forestal con CENTA o Desarollo Juvenil Communitario?

    1=Sí 2=No

Si si,

7. Hubo una parte del programa relaciondada a la siembra y cuida de arboles?

    1=Sí 2=No

II. Producción agrícola y silvícola

Podemos hacer un mapa de las parcelas que UD. esta cultivando este ano?

8. Cuántas fincas estan en pasto? ________

9. Cuántas tareas es la area de pasto? ________

10. Cuántas fincas son proprias o alquiladas?

Propria _______ alquiladas _______

11. Cuántas fincas cultiva Ud. con granos básicos? ________

12. Cuántas tareas es la area de los cultivos? ________

13. Cuántas fincas son proprias o alquiladas?

Propria _______ alquiladas _______

14. Tiene Ud. cultivos frutales o arboreas?

1=Sí 2=No

<u>Si si,</u>

15. Cuáles son las especies que cultivan, cuántos hay, y donde estan creciendo? Ud. puede marcar en el mapa donde estan estos arboles?

15.1=nance	#____	15.9 = citrus	#____
15.2=maranon	#____	15.10= almendro	#____
15.3=tamarindo	#____	15.11= aguacate	#____
15.4=quineo	#____	15.12= amona	#____
15.5=platano	#____	15.13= jicaro	#____
15.6=jocate	#____	15.14=coco	#____
15.7=mango	#____	15.15=mamones	#____
15.8=papayo	#____		

1=en parcela de pasto 2=en cultivo grano básico

3=en cerca viva 4=en huerta casera

5=por el nascimiento 6=otro _________

16. Quíen planto estos arboles?

1=Ud. 2=su padre 3=su madre 4=familia

5=nadie 6=dueno anterior 7=otro ________

Cópiar el mapa aquí

III. Información de Animales

17. Qué tipos de animales tiene Ud.

1=vacas 2=bueyes 3=caballos 4=taros 5=chivos

6=charchos 7-otro ________ 9=none

18. De los siguientes, cuántos de cada uno tiene Ud.?

Vacas _____ lecheras _____ bueyes _____ horro _____

chivos _____ caballos _____

19. Ha vendido Ud. algunos bovinos desde el verano pasado?

1=Sí 2=No

20. Cuáles fueron vendidas?

1=vacas 2=chivos 3=bueyes 4=toro 5=otro _____

21. Cuántas de cada uno ha vendido?

1=vacas

22. Por qué se vende los bovinos?

1=para comprar fertilizantes 2=para comprar semillas 3=para comprar herramientas

4=para cambiar para una vaca 5=dinero 6=viejo 7=otra _______

23. A dónde vende generalmente los bovinos?

1=Las Huertas 2=El Capitan 3=La Presa 4=San Alejo 5=San Miguel

6=otro_______

24. En qué mes vende generalmente los bovinos?

1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago 9=sep

10=oct 11=nov 12=dec 13=todo el ano

25. Qué tipo de comida da Ud. a los bovinos en invierno?

1=guate 2=pasto 3=concentrado 4=forage de arboles 5=otro _______

26. Qué planta?

1=guacimo 2=chupa chupa 3=fiquilote 4=guacaste 5=guebrado 6=jocte

7=medecoco 8=jiote

27. Qué usa para forrage durante el verano?

1=guate 2=hojas de arobles 3=pastos secos 4=todos

5=concentrado 6=otro ________

28. Dónde estan creciendo los arboles que usa Ud. para forage?

1=en medio del cultivo 2=pasto 3=camino 4=orilla 5=casa 6=otro ______

29. Entre todos estos lugares, de dónde viene la mayoria del forage de los arboles?

1=en medio del pasto 2=enmedio del cultivo 3=en cerca viva

4=en poste vivo 5=por el nascimiento 6=otro _______

IV. Producción lechera

30. Cuántas vacas esta ordenando esto dias? ____________

31. Cuántas veces por dia estan ordenando?

    1=uno 2=dos 3=otro ______

32. Los chivos mamam también?

    1=Sí 2=No

33. Cuántas botellas de leche produce en total por dia en el invierno? ____________

34. Bája la cantidad de leche en el verano?

    1=Sí 2=No

35. Cuántas botellas de leche produce en total por dia en el verano? ____________

36. Qué productos lecheras hace en casa?

    1=crema 2=queso 3=cuajada 4=otro ________

37. Si la cantidad de la leche baja en verano, la cantidad de los productos lecheras bája tambien?

    1=Sí 2=No

38. Quíen come generalmente los productos lecheras?

    1=hombres 2=mujeres 3=ninas 4=ninos 5=bebes 6=no aplicable

    7=todos 8=otro ________

39. De todo lo que produce, qué productos ha vendido el ano pasado?

    1=crema 2=queso 3=cuajada 4=otro ________

40. Dónde vende generalmente los productos?

    1=Las Huertas 2=El Capitan 3=La Presa 4=San Alejo 5=San Miguel

    6=otro ________

41. Cuándo vende generalmente los productos lecheras?

1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago 9=sep

10=oct 11=nov 12=dec 13=todo el ano 14=verano 15=invierno

16=cuando hay

42. Cuántas arboles hay en cada finca?

P#1 __________

P#2 __________

P#3 __________

P#4 __________

Agroforestería de Arboles en Disperso HH# ______

1	pueblo		
2	vida		
3	personas		
4	años		
5	grado		
6	programa		
7	arboles		
8	pasto		
9	tareas		
10	pro/arr		
11	granos		
12	tares		
13	pro/arr		
14	frutales		
15	cual		
16	planto		
17	animales		
18	Cuántos		
19	vendido		
20	cuales		
21	Cuántas		
22	porque		
23	donde		

24	Cuándo		
25	invierno		
26	planta		
27	forrage		
28	donde		
29	mayor		
30	vacas		
31	veces		
32	chivos		
33	botellas		
34	baja		
35	botellas		
36	productos		
37	baja		
38	quién come		
39	vendido		
40	donde		
41	Cuándo		
42	parcela		

<u>Arbol: se refiere a un arbol o arbusto</u>

<u>Instrucciones</u>: dibujar el mapa, completar el cuestionario, despues preguntarle si es posible de ver algunos arboles en disperso y hace cada progunta para todos los arboles en disperso que se encuentre.

---

1. Cómo se llama este arbol? ____________________________________

2. Esta planta es un arbol o un arbusto?

   1=arbol 2=arbusto

3. Dónde esta ubicado este arbol?

   1=en medio del cultivo 2=en medio del cultivo/pasto

Si el arbol esta en un potrero,

4. Cómo se llama este pasto?

   1=pasto mejorado (pangola, estrella, guatemala, o elefante)

   2= jaragua 3=saleja 4=otro __________

5. Cuántas vacas pastorean en este potrero? __________

Si el arbol esta en la finca de cultivos,

6. Cómo se llame el cultivo que esta sembrado alli ahora?

   1=pinn 2=post 3=n.a.

7. Cómo fue la produccion total en quintales en esta finca para el ano pasado (primera y la postera)?

Cúales son todos los usos de este arbol?

___

___

___

8. Entre todos los usos de este arbol, cuál es el uso que tiene mayor importancia para Ud.?

1=forage	5=medicina para gente
2=lena	6=medicina para animales
3=comestible	7=madera para muebles
4=sombra	8=madera para herramientas
	9=madera para construcciones
	10=postes

11=otro ___

9. Cuándo se utiliza este arbol para ___?

1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago 9=sep

10=oct 11=nov 12=dec 13=todo el ano 14=verano 15=invierno

16=al cortar 17=al desnochor 18=trabajo 20=otro ___

10. Qué partes del arbol se utiliza para ___?

hojas	1=cojollo	2=viejas		
corteza	3=nueva	4=vieja	5=afurea	6=adentro
ramas	7=verde	8=chicas	9=medianas	10=grandes
semillas	11=vainas	12=semillas	13=cascara	
fruta	14=verde	15=maduras		
	16=raizes			
	17=tranco			
	18=todo			
	19=corazon			
	20=otro ___			

11. Qué hace Ud. para conseguir ________________ del arbol?

1=corta y lleva
2=corta y daja
3=corta ramas
4=corta todo el arbol
5=corta las hojas
6=la corteza
7=cortar todo y asserar
8=colectar las frutas 7 comer/usar
9= colectar las frutas que had caido
10=deja que los animales comen las frutas
11=otro ____

12. Quíen viene a buscar ______________ del arbol?

1=Ud. 2=cipotes 3=todos 4=parientes 5=dueno 6=n.a. (se daja)

7=otro _________

13. Entre todos los usos de este arbol, cuál es el uso que tiene segunda importancia para Ud.?

1=forage 5=medicina para gente
2=lena 6=medicina para animales
3=fruta 7=madera para muebles
4=sombra 8=madera para herramientas
9=madera para construcciones
10=pasto
11=otro ___________________________

14. Cuándo se utiliza este arbol para ____________________?

1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago

9=sep 10=oct 11=nov 12=dec 13=todo el ano 14=verano

15=invierno

15. Qué partes de arbol se utiliza para ______________________?

hojas	1=nuevas	2=viejas		
corteza	3=nueva	4=vieja	5=tierna	6=dura
ramas	7=verde	8=chicas	9=medianas	10=grandes
semillas	11=vainas	12=semillas	13=cascara	
fruta	14=verde	15=maduras		
	16=raizes			
	17=tranco			
	18=otro ______________________________			

16. Qué hace Ud. para conseguir _________________________ del arbol?

1=corta y lleva
2=corta y daja
3=corta ramas
4=corta todo el arbol
5=corta las hojas
6=contar la corteza
7=sacar las raizes
8=colectar las frutas
9= colectar las frutas que han caido
10=deja que los animales comen las frutas
11=otro ____

17. Quíen viene a buscar _______________________ del arbol?

1=hombres 2=mujeres 3=ninas 4=ninos 5=no aplicable (e.g. se deja)

6=otro _______________

18. Entre todos los usos de este arbol, cuál es el uso que tiene tercera importancia para Ud.?

1=forage	5=medicina para gente
2=lena	6=medicina para animales
3=fruta	7=madera para muebles
4=sombra	8=madera para herramientas
	9=madera para construcciones
	10=pasto
	11=otro _______________________________

19. Cuándo se utiliza este arbol para ____________________?

1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago

9=sep 10=oct 11=nov 12=dec 13=todo el ano 14=verano

15=invierno

20. Qué partes del arbol se utiliza para ____________________?

hojas	1=nuevas	2=viejas		
corteza	3=nueva	4=vieja	5=tierna	6=dura
ramas	7=verde	8=chicas	9=medianas	10=grandes
semillas	11=vainas	12=semillas	13=cascara	
fruta	14=verde	15=maduras		
	16=raizes			
	17=tranco			
	18=otro ____________________			

21. Qué hace Ud. para conseguir ____________________ del arbol?

1=corta y lleva
2=corta y daja
3=corta ramas
4=corta todo el arbol
5=corta las hojas
6=contar la corteza
7=sacar las raizes
8=colectar las frutas
9= colectar las frutas que han caido
10=deja que los animales comen las frutas
11=otro ____________________

22. Quíen viene a buscar ____________________ del arbol?

1=hombres 2=mujeres 3=ninas 4=ninos 5=no aplicable (e.g. se deja)

6=otro ______________

23. Esta parcela es propria o arrendada?

1=propria 2=arrendada

Si es arrendada,

24. Su uso de este arbol para (mayor) _______________ esta prohibida en algun tiempo del ano?

    1=Sí 2=No

Si Si,

25. Cuándo esta prohibida el uso para ____________________?

    1=siempre 2=desnocha 3=con permiso seco se 4=otro ______________

26. Su uso de este arbol para (segunda) ______________ esta prohibida en algun tiempo del ano?

    1=Sí 2=No

Si Si,

27. Cuándo esta prohibida el uso para __________________?

    1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago

    9=sep 10=oct 11=nov 12=dec 13=todo el ano 14=verano

    15=invierno

28. Su uso de este arbol para (tercer) ________________ esta prohibida en algun tiempo del ano?

    1=Sí 2=No

Si Si,

29. Cuándo esta prohibida el uso para __________________?

    1=ene 2=feb 3=mar 4=abr 5=may 6=jun 7=jul 8=ago

    9=sep 10=oct 11=nov 12=dec 13=todo el ano 14=verano

    15=invierno

Hemos placticado de los usos, ahora vamos hablar del establecimiento del arbol.

30. Quíen sembro este arbol?

1=Ud. 2=su padre 3=su madre 4=pariente 5=nadie 6=otro ______

Si alguien lo sembro:

31. Ud. puede recordar en qué año fue sembrado? ________

32. Si Ud. no lo sembro, o no se recuedrda bien cuándo fue, cuántos años piensa Ud. que tiene este arbol? ________

33. Cómo fue sembrado?

1=semilla 2=estaca 3=plantita 4=otro __________

Se fue sembro por estaca,

34. Cuándo se cortan las estacas?

1=fin de verano 2=comienzo de invierno 3=durante invierno

4=todo el ano 5=otro ___________

35. Cuántas dias paso hasta que los sembro? 0=inmediato ____________

36. Entre 10 estacas sembradas, cuántas sobreviven? __________

37. Ud. siembra las estacas segun las fases de la luna?

1=Sí 2=No

38. Cuál(es) fases son mas favorables para la siembra de estacas?

1=nueva 2=llena 3=creciente 4=menguante 5=escondida

6=otro ________________

Si fue sembrada

39. Qué hace Ud. para asegurara que sobrvive el arbol recien sembrada?

1=cercar 2=estiercol 3=abono organico 4=fertilizante quimico

5=riego con agua 6=limpieza 7=otro ________________

40. Qué hace Ud. para asegurara que sobrvive el arbolito ya pegado?

1=cercar 2=estiercol 3=abono orgainico 4=fertilizante quimico

5=riego con agua 6=limpieza 7=otro ________________

41. Cuándo Ud. siembra con estacas de donde consiga la mayoria de las estacas?

1=proprio 2=parientes 3=vecino 4=bosque proprio

5=bosque en las comunidad 6=del borde del camino

7=otro ________________

42. Cuándo Ud. siembra por plantitas de donde consiga generalmente las plantitas?

1=proprio vivero 2=otro viviero 3=proprio bosque 4=otro bosque

5=otro ________________

Hemos hablado sobre los beneficios que tiene este arbol, ahora

43. Cuáles son las cosa negativas, osealas cosas que Ud. no le gusta de este arbol?

1=problemas de plagas (cuales) 2=ramas que cayan 3=atrae relampago

4=sombra 5=demasiado fruta 6=otro ________________

44. Qué hace Ud. para corregir esta problema?

1=poda el arbol 2=colectar las frutas 3=otro _____________

Estos son todoas las preguntas que yo tengo sobre este arbol, Me gustaria tomar unas mediciones del arbol, pero antes de esto, le pregunto a Ud. si queda alguna cosa quel le parece importante que yo sepa de este arbol?

____

____

____

46. Qué es el dap del arbol? ____________

47. Qué es la altura del arbol? ____________

48. Qué es el diametro de la copa?

#1_______ #2_______ #3_______ #4_______ promedio _________

Puedo tomarle una foto del arbol?

Puedo dibujar un mapa para localizar el arbol en relacion a los demas?

Muchas gracias por su tiempo y por la consulta!

1	llama		
2	arb/arb		
3	donde		
4	pasto		
5	# vacas		
6	cultivo		
7	produccion		
8	mayor		
9	cuándo		
10	parte		
11	hace		
12	quien		
13	segunda		
14	cuándo		
15	parte		
16	hace		
17	quien		
18	tercera		
19	cuándo		
20	parte		
21	hace		
22	quien		
23	pro/arren		

24	uso		
25	cuándo		
26	uso 2ndo		
27	cuándo		
28	uso 3ro		
29	cuándo		
30	planto		
31	ano		
32	cuántos		
33	plantada		
34	coradas		
35	dias paso		
36	de 10		
37	fases		
38	cual		
39	recien		
40	creciendo		
41	estacas		
42	plantitas		
43	no gusta		
44	corregir		
45	dap		
46	altura		
47	diametro		

APPENDIX H

Appendix H

Scientific name (family, genus and species) of dispersed trees found in farmers fields in Las Huertas, El Salvador from June to August, 1996

ANACARDIACEAE	*Anacardium occidentale*	L.
	Mangifera indica	L.
	Spondias mombin	L.
	Astroneum graveolens	Jacq.
	Spondias purpurea	L.
ANNONACEAE	*Anona reticulata*	L.
APOCYNACEAE	*Stemmadenia obovata*	(Hook & Arn.) Schum.
BIGNONIACEAE	*Tabebuia impetiginosa*	(Mart. ex DC.) Standl.
	Tabebuia rosea	(Bertol.) DC.
	Cresentia cujete	L.
BOMBACACEAE	*Ceiba pentandra*	(L.) Gaertn.
BORAGINACEAE	*Cordia alliodora*	(Ruiz & Pav.) Oken
	Cordia dentata	Poir.
BURSERACEAE	*Bursea simaruba*	(L.) Sarg.
COMBRETACEAE	*Combretum farinosum*	H.B.K.
FLACOURTIACEAE	*Casearia corymbosa*	H.B.K.
LEGUMINOSAE CESALPINIOIDEAE	*Hymanea courbaril*	L.
	Caesalpinia coriaria	(Jacq.) Willd.
	Haematoxylon campechianum	L.
	Cassia grandis	L.F.
LEGUMINOSAE MIMOSOIDEAE	*Mimosa tenuifolia*	(Willd.) Poiret
	Enterolobium cyclocarpum	(Jacq.) Greisb.
	Albizia caribea	(Urban) Britt. & Rose
	Lysiloma divarticatum	(Jacq.) Macbride
	Mimosa platycarpa	n.a.
	Acacia pennatula	(Schlecht. et Cham.) Benth
	Acacia farnesiana	(L.) Willd.
	Piptadenia constricta	(Micheli & Rose) Macbride
	Pithecellobium dulce	(Roxb.) Benth.
	Pithecellobium saman	(Willd.) Benth.
LEGUMINOSAE PAPILIONOIDEAE	*Gliricidia sepium*	(Jacq.) Kunth. Ex Greisb.
	Andira inermis	(W. Wright) D.C.

Appendix H (cont'd)

	Piscida carthagenensis	Jacq.
	Lonchocarpus minimiflorus	Donn. Smith
MALPIGHIACEAE	*Brysonima crassifolia*	(L.) H. B. K.
MELIACEAE	*Swietenia humilis*	Zucc.
MORACEAE	*Cholophora tinctoria*	(L.) Grand.
MYRTACEAE	*Psidium guava*	L.
	Eucalyptus sps.	n.a.
RHAMNACEAE	*Karwinskia calderoni calderonii*	Standl.
RUBIACEAE	*Richardia scabra*	L.
	Exostema caribaeum	(Jacq.) Roem. & Schult.
	Calycophyllum candidissimum	(Vahl) DC.
	Genipa americana	L.
SAPINDACEAE	*Thounidium decandrum*	(H. & B.) Radlk.
SIMAROUBACEAE	*Simarouba glauca*	DG.
	Alvaradoa amorphoides	Liebm.
STERCULIACEAE	*Guazuma umlifolia*	Lam.
TILIACEAE	*Luehea candida*	(DC.) Mart.

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