UNIVERSITY OF ALBERTA

AGROFORESTRY IN BELIZE: MAYA HOME GARDENS IN SAN LUCAS

by

M. LYNN PATTERSON ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Science

in

AGROFORESTRY

Department of Renewable Resources

Edmonton, Alberta

Fall 2000

0-612-59862-4

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DEGREE: Master of Science

YEAR THIS DEGREE GRANTED: 2000

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September 1, 2000

"A gardener or botanist of north European antecedents accustomed since childhood to associating the orderliness of field crops and of vegetable gardens with industry and thrift, has difficulty in evaluating the native gardens of Central America. Sometimes he does not even recognize them as being gardens. Only gradually does he come to realize that what at first sight seemed to be rather weedy dump heaps are actually efficient and productive. Understanding breeds interest as well as respect. A consideration of these native gardening techniques gives one new insight into the probable history of various cultivated plants and the evolution of agriculture. It also suggests that some of the problems of tropical and subtropical agriculture might be solved by a judicious blending of aboriginal and modern practices" (Anderson, 1950).

ABSTRACT

This study examines the agroforestry practice of home gardening in the Kekchi Maya village of San Lucas, Toledo District, Belize, Central America. A gender perspective was stressed over the course of the research since women are the principal home garden managers. The purpose of the study was to relate selected socio-economic and cultural factors, that may influence the decision making processes of gardeners, to the structure and function of their home gardens. In doing so it was expected that an increased understanding of forces that motivate decision makers could be used, by professionals (academics and scientists) and extension personnel, as development tools when collaborating with local Maya subsistence and semi-subsistence producers. The Government of Belize and many Maya producers are interested in exploring sustainable alternatives and modifications to more traditional means of production because, despite HHs selecting variable livelihood strategies, such as home gardening, the ecological conditions in Toledo District are at risk due to the worsening problem of land pressure.

Results of the research imply important relationships between resources, both physical and metaphysical, available to gardeners and HHs as they select specific combinations of livelihood strategies and derive the economic and environmental outcomes of these strategies. In addition, issues surrounding the uncertainty of communal land tenure and lack of access to markets also influenced decisions regarding home garden management among gardeners in San Lucas.

Factors influencing home garden dynamics provide insights for development professionals and local extension personnel who will collaborate with gardeners to implement effective projects, programs and policy changes as a means of promoting the sustainable use of resources while continuing to meet human needs.

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled AGROFORESTRY IN BELIZE: MAYA HOME GARDENS IN SAN LUCAS submitted by M. LYNN PATTERSON in partial fulfillment of the requirement for the degree of MASTER OF SCIENCE in AGROFORESTRY.

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ACKNOWLEDGMENTS

Many thanks to my supervisor, Dr. Richard Rothwell, for his support and for putting up with me during the research and production stages of this thesis. Research funding was provided by the Canadian Bureau for International Education (CBIE) and the International Development Research Council (IDRC). Special thanks to the staff at Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) in Costa Rica.

Throughout my life I have been fortunate to have met some extraordinary people who deserve honourable mention, a sincere thank you and a big hug. This "book" is for my lifelong friend's, Claire, Emma, Karen, Sharon and Susan. I love them all and hope they will be a part of my life in years to come. They all helped me in different ways and endured my writing days when I was grumpy and "keeping to my cave." The field research had it's ups and downs and I couldn't have completed it without the unfailing support of "Teacher" Emma Martinez, Sharon and Rose Palacio, Nora and Tim Bardalez, Curlette and Ludwig, Sharren, Sheena and Lisa. Many, many thanks go to the villagers of San Lucas who were wonderful and without their cooperation and patience this document would not exist. Others who impacted my life were my mother, who was willing to help in any way that she could, my 'sweetie' (he knows who he is) and Karl.

Finally, I would like to thank two people, now deceased, who left lasting impressions on my life and helped to shape the person that I am today. Aunt Tess, who travelled the world when women didn't "do those things", instilled in me my never-ending curiosity about the world and it's people. To my father, who died tragically while I was conducting my field research, I offer my thanks for his presence in my life. This is my opportunity to say: I love you and good bye!

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ACRONYMS AND DEFINITIONS

BHAR	British Honduras Annual Report
BMB	Belize Marketing Board
CATIE	Centro Agronomico Tropical de Investigacion y Ensenanza
CSO	Central Statistics Office, Government of Belize, C.A.
D & D	Diagnostic and Design Approach: a holistic approach that emphasizes the role of trees within the farming system and places a greater emphasis on the iterative nature of the diagnostic and design process than do other, longer established methods.
dehathi admi	rural people (Pakistan)
FAO	Food and Agriculture Organization of the United Nations
FHH	female headed household/female head of household
FSR/E	Farming Systems Research/Extension
GNP	Gross National Product
GOB	Government of Belize
HH	household
IAK	indigenous agricultural knowledge
ICRAF	International Centre for Research in Agroforestry
IDRC	International Development Research Centre
IHH	Intra-Household or gender analysis technique
ITK	indigenous technical knowledge
km(s)	kilometer(s)
m	meter
mecate	Spanish measure of land (25' x 25')

MHH	male headed household/male head of household
MOA	Ministry of Agriculture and Fisheries, Belize, C.A.
NARMAP	Natural Resource Management and Protection Project
NGO	non-governmental organization
pet kot	home garden
PRA	participatory research approach
SAP	Sustainable Agricultural Production
SOFA	State of Food and Agriculture Reports, FAO
TAMP	Toledo Agriculture Marketing Project
TBK	traditional botanical knowledge
TEK	traditional environmental knowledge
TMCC	Toledo Maya Cultural Council
TRDP	Toledo Rural Development Project
TRDP	Toledo Research and Development Project
TSFDP	Toledo Small Farmers Development Project
USAID	United States Agency for International Development

CHAPTER ONE

I. INTRODUCTION

This study focuses on the agroforestry practice of home gardening in the Kekchi Maya village of San Lucas, located in the Toledo District of southern Belize, Central America (Figure 1.1, page 2). A gender perspective was stressed over the course of the research since women are the principal garden managers. Conducted over a period of 12 months, in 1995 and 1996, the purpose of the study was to relate selected socio-economic and cultural factors, that may influence the decision making processes of gardeners, to the structure and function of their home gardens. In doing so it was expected that some, or all, of the selected factors would provide development professionals and local extension personnel a better understanding of some of the forces that may motivate gardeners to adopt and modify, or to reject new and/or different scientific technologies. An increased understanding of some of the forces that affect the structure and function of home gardens is a tool that can be used by development professionals and extension personnel when collaborating with local Maya subsistence and semi-subsistence producers in exploring alternatives and modifications to their traditional means of production. Alternatives and modifications are sought to mitigate the expanding problem of land pressure in Toledo District. To date, development projects have been the most frequent method utilized for exploring alternatives to existing production systems.

In general, problems with the implementation and "success" of development projects in southern countries, including Belize and Toledo District, are often attributed to poor literacy and backwards cultural tendencies among target groups (local people) and associated problems with technology transfer.

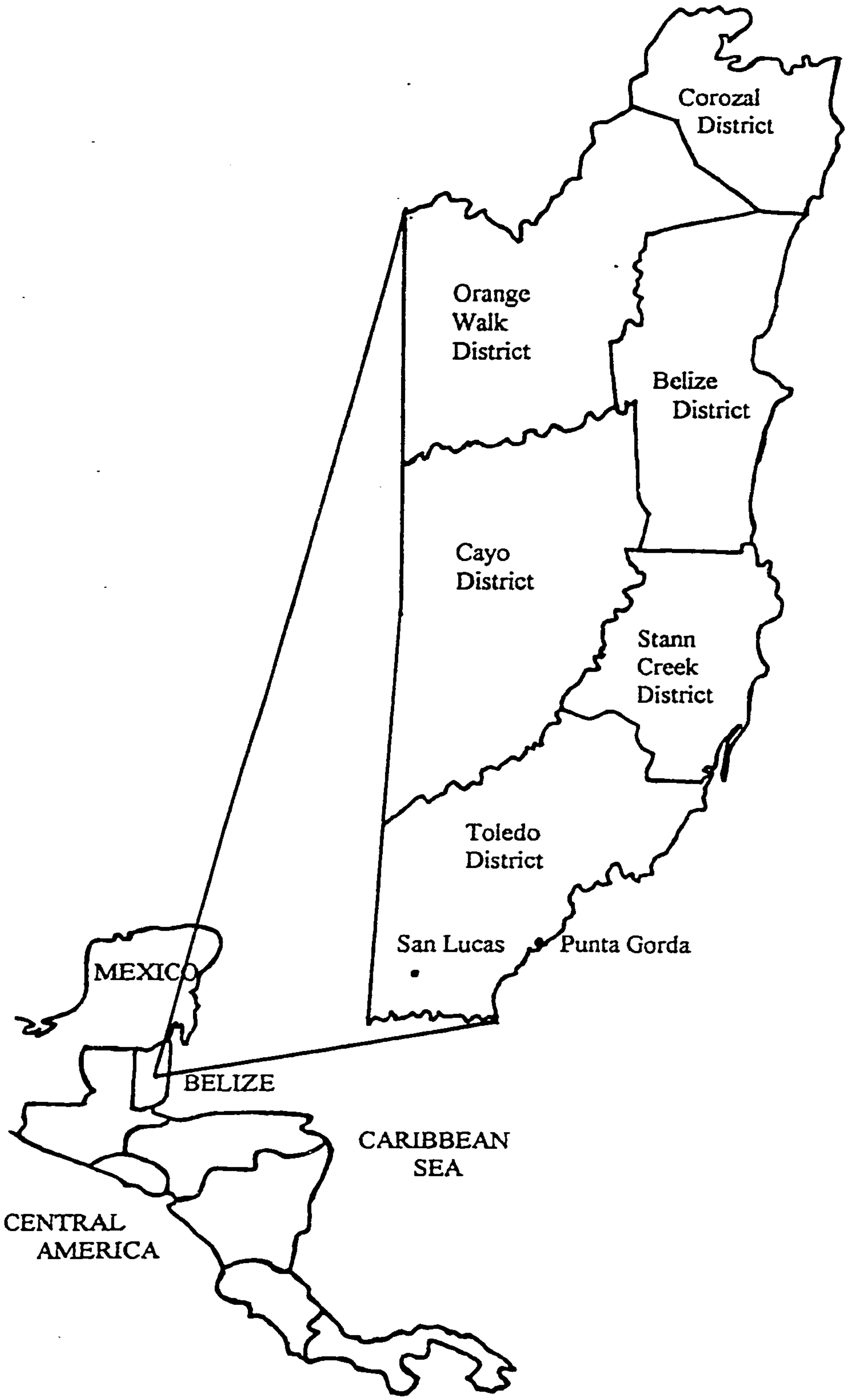


Figure 1.1 Geographic Location of San Lucas, Belize, Central America.

Source: Modified from King *et al.*, 1986.

The lack of success in many projects may simply be explained by the development professional (academics and scientists), local extension personnel or the farmer not understanding the motivations of the other and not desiring the same outcomes. For example, the goals of a development project may be formulated based upon needs and priorities perceived by geographically distant government officials and development agencies, rather than upon collaboration with individuals from the target group. Further, the methods used to implement such a project may be based on "long-established procedures for conducting patron-client relations [that are] rigorously restricted to a tiny fraction of the rural population" (Dove, 1992). Regrettably, there is often a clear predisposition among development professionals and extension personnel toward selecting project participants (key farmers) they have previously worked with and those that are recognized as "innovators" or "early adopters" (Rogers and Shoemaker, 1971). These people are considered the most likely to embrace a new technology (i.e., the most "progressive", meaning those with the most land, best facilities and highest education) and are often interested in serving the needs of the national market (Dove, 1992). This is not to suggest that local extension personnel know nothing about their target groups, but their understanding and knowledge of local conditions may not be as comprehensive as they imagine, thereby hindering the implementation of projects. Dove (1992) provides an excellent example from Pakistan where foresters "maintained that by virtue of working in rural areas, frequently interacting with rural people, and perhaps originally coming from rural backgrounds themselves, they were *dehathi admi* "rural people" themselves and "experts" on rural life. [In reality], the forester is a trained expert on forests, not on the people who live in or near the forests."

Clearly, the old one-way, or top down, model of communication between development professionals, extension personnel and members of target groups has not proven an effective strategy for rural development. The current movement is toward a participatory research approach (PRA) that stresses a two-way flow of information between professionals and the local community where reliance is placed on knowledge possessed by intended users. It goes without saying that strategies of land management developed in close collaboration with the intended users, emphasizing an understanding of what motivates their lifestyle choices, should have a far greater likelihood of succeeding than those imposed from above.

This study proposes that utilization of a participatory research, problem-solving approach, inherent in the 'Diagnosis and Design' methodology (Raintree, 1987) developed for agroforesters at the International Centre for Research in Agroforestry (ICRAF), could lead to the development of more sustainable land management activities in the Maya inhabited area of Toledo District. Preference for utilizing such an approach is "based on the assumption, borne out by experience, that those technologies which realize potentials for solving perceived problems in the existing land-use system are more likely to awaken the client's adoption interest than those which do not. Such technologies would tend to...achieve greater relevance to the farmer's decision-making process by addressing perceived needs" (Raintree, 1983).

1.0 HOME GARDENING: AN AGROFORESTRY PRACTICE

The home garden is considered "the agroforestry system that shows the greatest complexity and diversity..[and is] probably one of the most interesting agroecosystems, and possibly the one we have most to learn from regarding resource management for sustainable agriculture.." (Gliessman, 1990). Although Gliessman suggests that knowledge obtained from the study of home gardens is potentially important to sustainable agricultural practices, it is interesting to note that home gardens are quite possibly the least represented practice in agroforestry literature (Mercer and Miller, 1998). For example, home gardens have been widely studied in Asia and Africa (Landauer and Brazil, 1990) for many years, while sources from the neo-tropics (Gillespie *et al.*, 1993; Lentz, 1993; Padoch and de Jong, 1991; Wilk, 1991; Rico-Gray *et al.*, 1990; Works, 1990; Ninez, 1984; Denevan *et al.*, 1984; Beckerman, 1983; Boster, 1983; Alcorn, 1981; Brierley, 1976; Anderson, 1950) are disproportionate over time and virtually non-existent from the study area in southern Belize.

Researchers and government extension personnel know very little about home gardens in the study area even though information obtained from home garden research is considered a potentially useful component in solving problems of land pressure (King *et al.*, 1995; Marcus, 1995), resource management and sustainability that are beginning to surface within the Maya communities in Toledo District. Past research efforts, designed to explore resource use among the Maya inhabitants of southern Belize, were limited to explorations of household variation, labour investment and commercial production strategies as they relate to extensive agricultural practices (Emch, 1992; Wilk, 1991; Berte, 1983). With the exception of Wilk (1991), sources barely mention Maya home gardens in southern Belize.

In addition to the lack of home garden information available from this area and the inaugural nature of this study, it is intrinsically valuable to document agroforestry systems and practices before the knowledge and information is lost completely. Since land-use systems are unique and dynamic, varying with local environmental, social, cultural and economic conditions, changes can be rapid.

Further, government representatives from the Belize Ministry of Agriculture and Fisheries (MOA) supported my study in Toledo District because of reports of food shortages in many Maya villages, encroachment of slash and burn agricultural activity on steep rocky slopes and trespass into government controlled Forest Reserves. The Government of Belize (GOB) recently declared agroforestry as one of their priority areas for further investigation and development; thus, it supported an agroforestry project being conducted in the area with the hope that forthcoming results could be utilized by extension personnel and agents from non-governmental organizations (NGOs) engaged in environmental conservation and rural development activities.

2.0 CHAPTER OUTLINES

Chapter two will provide the reader with background knowledge about Belize, the demographics, an overview of the importance of tropical forests from a global perspective and a short discussion of agroforestry as one potential method of addressing some of the world's land-use problems. The situation in the research area is also presented, including a section outlining previous development projects and factors thought to have contributed to the lack of success achieved.

In chapter three, brief definitions and background narratives are provided for agroforestry and home gardens. Examples and illustrations are included as deemed necessary. Home gardens managed by Maya peoples in Central America, both past and present are discussed. Following are general sections, pertinent to the themes of this thesis, which present perspectives and definitions related to women and agroforestry, households (HHs), decision making processes and traditional environmental knowledge (TEK).

Chapter four provides fundamental information about the Kekchi Maya in southern Belize; who they are, where they originated and how they live. Some discussion will be devoted to describing the subsistence agricultural practices of the Kekchi Maya in order to place specific units of production into context for the reader. Land tenure and organization of labour among the Kekchi will also be described because they have influenced past and current systems of production and most probably will have significant impact upon future land-use decisions.

Chapter five begins with a description of the physical characteristics found in the study area, followed by the process of site and sample selection. A short discussion of the governing framework for the research (i.e., D and D approach and IHH technique) will be presented, followed by discussion and justification of research methods. These include: participant observation, formal and semi-structured (informal) interviews, interview schedules and focus group discussions. A section entitled cross-cultural research and communication precedes a statement regarding methods used to analyze the data.

Chapter six presents the qualitative and quantitative results of the research and discussion.

Chapter seven consists of conclusions and recommendations.

CHAPTER TWO

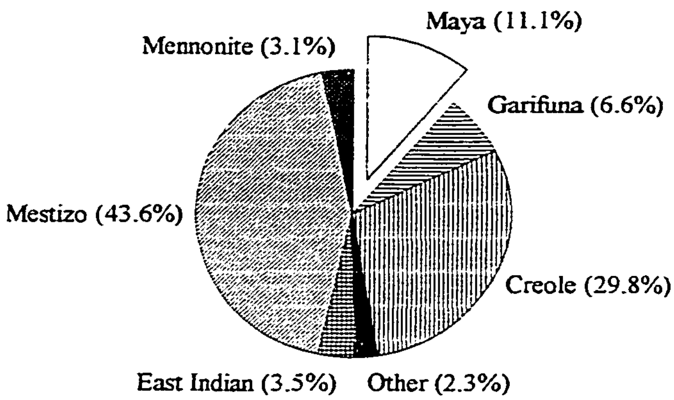
II. BACKGROUND

1.0 BELIZE DEMOGRAPHICS IN BRIEF

Belize, known as the colony of British Honduras since it's founding in 1862, declared independence from Britain in 1981. Located in northern Central America, Belize encompasses an area of 22,700 square kilometers or 8,867 square miles, which is roughly equivalent in size to one half of Vancouver Island or four times that of Prince Edward Island. It is bounded to the north by Mexico, to the west and south by Guatemala and to the east by the Caribbean Sea (Figure 1.1, page 2). In 1995 the population of Belize was estimated to be 216,500, with a population density of 9.5 persons per square kilometer (24.4 persons per square mile) (CSO, 1994). It continues to be the most sparsely populated country in Central America. The economy is oriented toward commercial and subsistence agriculture, forest-based production and relies heavily on tourism earnings and monies from expatriates living mainly in the United States. Currently, agriculture and the service industry are the most important sectors of the Belize economy, each accounting for about 40% of GNP. Agriculturally, the Belize economy is dependent on commercial citrus, banana, fish and particularly, sugar production. The latest estimate of GNP per capita is approximately US $1,000 (CSO, 1994).

Population distribution and land use is primarily determined by economic and environmental factors (i.e., climate, hydrology, vegetation, soils), topography, political partitioning and strategies and management plans developed by local producers. Only about 2% of land in Belize is used for agricultural production; while 15,000 square kilometers (approximately 65% of the total land mass) has agricultural potential that is limited by the following factors: drainage (30%), shallowness or rocky (5%), inherent low fertility (20%) or a lack of moisture in the dry season (15%) (Nicolait *et al.*, 1984). The population of Belize is divided into the following broad ethnic groupings:

Figure 2.1 Population by Ethnic Group
(CSO, 1994)



The national census of 1991 indicated that Mestizos (mixed descendants of indigenous Maya Indians and Europeans) made up more than 40 percent of the total population, followed by Creoles at 29.8% (mixed descendants of African slaves and Europeans) and Maya Indians (of which 4.3% are Kekchi, 2.7% are Mopan and 3.1% are Yucatecan). Smaller groups include the Garifuna at 6.6% (mixed descendants of African slaves and Amerindians), East Indians at 3.5%, Mennonites at 3.1% and others, which include Whites, Chinese, Syrians, Lebanese at 2.3% (CSO, 1994). English is the official language, although the majority of the population commonly converse using an English based Creole or Spanish, the latter a result of the large Mestizo population.

2.0 TROPICAL FORESTS: SIGNIFICANCE AND THREATS

Belize has recently come under scrutiny, as many other southern countries have, because deforestation of their tropical rainforest is assumed to be a result of slash and burn agricultural practices conducted by subsistence farmers and extensive commercial logging operations. The sustainable management and utilization of tropical forests is important because they are acknowledged to be essential in many ways, including, but not limited to:

- providing dwelling places for more than 200 million people in the tropics (Brown *et al.*, 1991)
- regulating watersheds
- controlling soil erosion and flooding
- maintaining soil fertility and systems of nutrient recycling
- creating under-canopy microclimatic zones suitable for specific types of vegetation
- maintaining biodiversity and genetic variation (Costanza, 1991; Randall, 1991; Dixon and Sherman, 1990; Barbier, 1989; McNeely, 1988) which buffers against changes in the environment (including those brought about by pests, diseases and climate change)
- provides genetic breeding material for humans to utilize in adapting plants and animals to a range of environments and end uses.

Traditionally, extraction without renewal has been the most common means of harvesting tropical forests and people around the globe have to deal with the consequences at local, national and international levels. Repercussions range from reductions in the quantity of arable land available for food production and associated nutritional and health problems to broader physical processes such as "global warming."

Not only does the destruction of tropical forests affect biodiversity and other planetary systems, but it impacts those people who inhabit tropical forests and derive a living from forest resources. In general these people are poor subsistence and semi-subsistence producers who represent a segment of the world's population that is politically and ecologically marginal. They often do not receive the benefits of public investment in services or infrastructure that could be used to maintain or increase food production levels in an ecologically appropriate and sustainable manner. The history of the Green Revolution bears this out.

During the 1950s and 1960s the Green Revolution created tremendous optimism among scientists and land-use practitioners that the progress of western science would increase agricultural production throughout the world. However, poor farmers were largely unable to participate in the "miracle" of the Green Revolution because they couldn't afford to pay for irrigation networks, pesticide, fertilizer and perhaps for the land on which their title was vulnerable and tenancy uncertain (McNamara, 1973). When farmers were unable to gain yields on their own farms comparable to those achieved at experimental stations, research became focused on the constraints within local farming systems and led to a re-evaluation of the priorities within agricultural research. Development professionals (both academics and practitioners) became more aware of the decisions facing resource-poor farmers and the need to complement existing research and extension activities with an approach that starts with the knowledge, problems and priorities of farmers themselves (Elliott, 1994). Under this approach, termed 'Farmer First', it becomes apparent that the behaviour of farmers is more commonly affected by their socio-political, economic and environmental circumstances, rather than their inability to understand or failure to implement land-use decisions which will raise productivity or conserve resources. The problem for researchers and extension personnel, therefore becomes not how to transfer technology from research station to farmer but how to incorporate insights from both (Elliott, 1994) to develop sustainable land-use practices. This is the concept of participatory research, where "the prioritization of problems is based on local knowledge, and where much of the research into possible solutions is carried out by local participants" (Richards, 1985).

3.0 AGROFORESTRY: A MEANS OF ADDRESSING LAND-USE PROBLEMS?

One possible method of addressing some of the world's land-use problems, while developing sustainable land-use practices that incorporate the knowledge of farmers, is through implementation of agroforestry strategies. Agroforestry is defined as:

> "a sustainable management system for land that increases total production, combines agricultural crops, tree crops and forest plants and or animals simultaneously or sequentially, and supplies management practices that are compatible with the cultural patterns of the local population" (Bene *et al.*, 1977).

Inherent in this definition are three key elements: sustainability, productivity and adoptability; all being of equal importance to the achievement of the producers goals and needs and implying a Farmer First approach. The first, sustainability, as defined by the World Commission on Environment and Development (1987), is "development that meets the needs of the present without compromising the ability of future generations to meet their needs." In developing nations a sustainable approach to development requires that:

> "the strategies which are being formulated and implemented are environmentally sustainable over the long-term, are consistent with social values and institutions, and encourage "grassroots" participation in the development process... In general terms, the primary objective is reducing the absolute poverty of the world's poor through providing

> lasting and secure livelihoods that minimize resource depletion, environmental degradation, cultural disruption, and social instability" (Barbier, 1989).

It becomes clear that improving the situation of today's poor is equally as important as the sustainable use of natural resources for tomorrow. Improving options for today's poor include increasing agricultural yields and maintaining productivity levels for farm families. How can this sustainable economic, ecological and social development be achieved? One potential method is through introduction of improved or new agroforestry technologies that conform to local farming practices (Nair, 1993), thereby increasing the possibility of being adopted by farmers.

But, a question remains: under what conditions are adoption of new agroforestry technologies most likely? Scherr (1995) suggests that adoption by farmers "is most likely where [new technologies or strategies are] consistent with incentives for land use change", such as: productivity, risk, marketability of new additions, cost and number of inputs, changes in labour requirements and access to land. Assuming the truth of this statement, it becomes clear that farmer adoption hinges on environmentally, socially and economically appropriate factors, as well as the assurance that current productivity and sustainability will not be negatively impacted by modifications to existing systems and practices. However, the distinction between adoption and non-adoption can be misleading since extension personnel measure the success of knowledge transfer by the percentage of farmers who adopt a technology according to the recommendations of the extensions agents. The reality is that farmers will likely experiment with different technologies and select elements that are applicable to their constantly changing circumstances (Elliott, 1994). This demonstrates that current measurements of success employed by governments, organizations and practitioners do not take into account factors that influence the farmer/producer when making land-use decisions. A Farmer

First approach takes into account that adoptability, and subsequent sustainability and productivity hinge on the appropriateness of technologies which, in turn, depend upon the input of local farmer/producers. Agroforestry strategies can more readily complement the Farmer First approach if they are implemented based on an understanding of local socio-political, economic and environmental conditions, all of which generally assume the participation of local farmers/producers and first hand observation and experimentation.

4.0 SITUATION IN THE STUDY AREA: TOLEDO DISTRICT, BELIZE, C.A.

In Toledo District the consequences of competitive utilization of tropical forest resources (i.e., slash and burn or milpa agriculture practiced by Maya subsistence farmers and commercial logging operations) are becoming evident in Maya Indian Reserves throughout the district and on Crown lands.

Between 1970 and 1985 areas under cultivation (including abandoned lands), mostly in the northern settlements of Toledo District, increased by some 61% while forestry plantations virtually disappeared (King *et al.*, 1986). Analysis of aerial photos by King *et al.* (1986) are summarized in the following table:

Table 2.1 Land-Use. Toledo District. 1970 and 1985.

	% of land under agriculture	Milpa	Permanent Cropping	% of land under forestry plantations	% of Mahogany	% of Pine
1970	3.7%	3.2%	0.5%	0.3%	73%	27%
1985	6.1%	4.8%	1.3%	0.1%	ND	ND

ND = no data available.

More current figures were not available at the time the research was conducted.

Increasing land pressure, sometimes vocalized by Maya villagers (King *et al.*, 1995), brought about by population growth among the Maya inhabitants and emigration is demonstrated by the fracturing and re-location of villages, disputes over community boundaries and encroachment of Maya subsistence farmers onto government regulated Forestry Reserves (King *et al.*, 1995; Marcus, 1995; Jenkins *et al.*, 1978). This is further complicated by the Government of Belize (GOB) issuing commercial logging permits for some Forest Reserves, portions of which are currently being utilized by Maya subsistence farmers. The land-use problem is complex, involving a growing Maya population that requires land for subsistence and commercial production activities and a government that requires foreign dollar income provided by commercial logging activities and agricultural export production.

Over the past two or three decades efforts to address land-use problems in Toledo District have focused on the almost continuous technical assistance provided by internationally funded projects, such as:

- TAMP (Toledo Agriculture Marketing Project). A project focused on the introduction and dissemination of alley cropping as a substitute for shifting or milpa cultivation.
- TRDP (Toledo Rural Development Project). A project focused on introducing new systems of agriculture to the area which would improve production and therefore rural living standards as well as to provide alternative systems to upland "slash and burn" (milpa) practices.
- TSFDP (Toledo Small Farmers Development Project). The objectives of this project were to "significantly replace" the existing system of shifting cultivation among small farmers by offering assistance to adapt to improved, stabilized systems

and to upgrade farm input supply facilities and essential market channels, as well as to supply credit.

- SAP (Sustainable Agricultural Production) is a component of the NARMAP (Natural Resource Management and Protection Project) project. The objective of the SAP program in Toledo was to develop sustainable agriculture that would eliminate the need for cultivating large areas and clearing additional forest lands. The focus was on hillside land/crop management.

Project evaluations have consistently identified two key factors which contribute to the failure to reach development goals, and by implication, to improve the human condition of the target group. These are:

- A failure to appreciate the needs and capacities of target populations (i.e., Maya and East Indian populations), and to include them in all phases of project planning and implementation.
- The compression of the time element needed to permit the introduction, implementation, and germination of new ideas, technologies and methods.

In sum, projects have failed because they were superimposed onto existing social settings which could not sustain them in their planned form. Human factors, rather than material or economic lessons were the principal cause of project failure (Toledo Research and Development Project (TRDP): Proceedings of Final Workshop, February 27/28, 1986. Blue Creek, May, 1986).

CHAPTER THREE

III. DEFINITIONS AND CONCEPTS

1.0 AGROFORESTRY: PERSPECTIVES

Considered to be a promising strategy for addressing some of the world's land-use problems, agroforestry is a form of land-use and management that is based in antiquity and well known to millions of farmers and forest-dwellers throughout the world today. There are many examples of traditional land-use practices involving combined production of trees and agricultural species on the same piece of land. These are some examples of what is now known as agroforestry. In Central and South America it has been a traditional practice for millennia for farmers to plant several dozen species of plants, in herbaceous and annual, shrub and perennial layers, on plots ranging in size from less than 0.5 to several hectares (Fernandes and Nair, 1990; Gomez-Pompa and Kaus, 1990; Budowski, 1985; Ninez, 1985; Allison, 1983). In Asia and Europe types of shifting cultivation were practiced that integrated agricultural and trees crops and in Africa intensive systems mixed herbaceous, shrub and tree crops on the same piece of land (Nair, 1993).

Efforts to define agroforestry as a form of land management that is applicable to both farm and forest began in the mid-1970s as a result of increasing global concern for the spread of tropical deforestation and ecological degradation in combination with concerns that the basic needs of the world's poor were not being adequately addressed (Nair, 1993; McNamara, 1973). It was thought that tropical forests were under persistent stress resulting from a range of factors such as commercial exploitation and fuelwood demands to shifting cultivation. In 1977 the president of the International Development Research Centre (IDRC), located in Ottawa, Canada, responded to these concerns by retaining Mr. John Bene to study the problem. Bene's team, in conjunction with regional experts from around the globe, concluded that "the solution to the problems besetting tropical forests arose from population pressure exerted through the need to produce food and fuelwood" (Steppler, 1987). From this initial research evolved the concept of agroforestry, defined as:

> "Agroforestry is a sustainable management system for land that increases total production, combines agricultural crops, tree crops and forest plants and or animals simultaneously or sequentially, and supplies management practices that are compatible with the cultural patterns of the local population" (Bene *et al.*, 1977).

In the late 1970s and early 1980s, as studies began on the diversity and scope of agroforestry practices, the field suffered from an excess of definitions and a general lack of common understanding caused by a scarcity of hard information. These early struggles to define an expansive new area of study were documented in the inaugural issue of Agroforestry Systems (Vol. 1, No. 1, pp. 7-12; 1982) where a selection of definitions, proposed by various authors, were reviewed in an editorial entitled "What is Agroforestry." These interpretations were discussed and refined at the International Council for Research in Agroforestry (ICRAF) and the following definition of agroforestry was proposed:

> "Agroforestry is 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" (Lundgren and Raintree, 1982).

Although the debate is occasionally rekindled (e.g., Somarriba, 1992), the ICRAF definition, above, is commonly utilized and has become widely accepted among researchers and practitioners alike. "The definition implies that:

- agroforestry normally involves two or more species of plants (or plants and animals), at least one of which is a woody perennial;
- an agroforestry system always has two or more outputs:
- the cycle of an agroforestry system is always more than one year; and
- even the simplest agroforestry system is more complex, ecologically (structurally and functionally) and economically, than a monocropping system" (Nair, 1993).

Agroforestry systems are unique and site-specific, varying from region to region. They are based on the social, economic and environmental factors specific to each community, area or region. Agroforestry is frequently proposed as a means of addressing land degradation, as well as shortages of food, medicines, fuelwood, cash income, animal fodder and building materials. But the reality is that agroforestry is only one option that can be selected to improve land-use in any given situation. The tangible benefits of agroforestry may range from improvements in human nutrition and increased income opportunities for farmers to soil improvements, potential reductions in erosion, increased productivity, reduced risk of complete crop failures, and use of shade to increase product and crop diversity. In addition, individuals may choose to plant a variety of tree species for aesthetic purposes or spiritual uses. On the other hand, some disadvantages of agroforestry may include increased competition, damage to trees and crops from livestock, allelopathy, potential for increased erosion and habitat or alternative hosts for pests. However, these disadvantages are generally not significant if a system is tested on site.

In agroforestry systems human beings manage a woody perennial (tree, bamboo, palm) component, in addition to a herbaceous (agricultural crops, including pasture species) and/or an animal component. Combinations of these lead to a broad classification of agroforestry systems (Nair, 1993, 1985; MacDicken and Vergara, 1990) as follows:

- agrisilvicultural (crops, including shrubs and vines, and trees)
- silvopastoral (pasture/animals and trees)
- agrosilvopastoral (crops, pasture/animals and trees)

Agroforestry systems can be further broken down into:

- structure of the system (biological nature and spatial and temporal arrangement of components),
- function of the system (role and output of components),
- agroecological zones where the system exists or is adoptable, and
- socioeconomic scales (low input, high input) and management levels of the system (i.e., subsistence, commercial) (Nair, 1993).

A problem commonly encountered when discussing definitions and concepts of agroforestry occurs when the words "system" and "practice" are used synonymously in agroforestry literature, as they are in other forms of land-use. The distinction between the two is clear because an agroforestry system is a specific local example of a practice, characterized by environment, plant species and their arrangement, management and socioeconomic factors. In contrast, an agroforestry practice denotes a distinctive arrangement of components in space and time. Although hundreds of agroforestry systems have been recorded, they all consist of about 20 distinct agroforestry practices, including: home gardens, shifting cultivation, bush fallow, alley cropping (hedgerow intercropping), shelterbelts, windbreaks, live fences and hedgerows, fuelwood and multipurpose woodlots, and many other systems where farmers and herders combine trees with field crops or animals. Detailed descriptions of some of these tropical and temperate zone systems are available in Nair (1993).

2.0 THE HOME GARDEN: AN AGROFORESTRY PRACTICE

Gardens are probably the most universally familiar example of small-scale agricultural intensification, with home or household gardens representing one of the most familiar and widespread production systems in tropical and subtropical zones. Home or household gardens are brilliantly defined by Ninez (1985) as follows:

> "The household garden is a subsystem within larger food procurement systems which aims at production of household consumption items either not obtainable, readily available, or affordable through permanent or shifting field agriculture, hunting, gathering, fishing, livestock husbandry, or wage earning. Household gardens supply and supplement subsistence requirements and generate secondary direct or indirect income. They tend to be located close to permanent or semi-permanent dwellings for convenience and security."

While the structure, location, size and types of crops grown vary, household or home gardens are often seen as "secondary sources of food and income, while field production, animal husbandry, wage labour, or trading are the major sources of support" (Cleveland and Soleri, 1991). Although much has been written about home gardens, the majority of the literature has been limited in scope to qualitative descriptions of traditional land-use practices located around HHs. Home gardens have a long tradition in many tropical countries and can be found in most areas where subsistence land-use systems prevail. Examples of home gardens from Asia and Africa dominate the literature (Landauer and Brazil, 1990), while other areas of the world, particularly Latin

America, are currently under represented (Mercer and Miller, 1998) in their examination of home gardens.

The term "home garden"; although variously defined as mixed-garden horticulture (Terra, 1954), mixed gardens (Stoler, 1975), house gardens (Padoch and de Jong, 1991), compound farms (Lagemann, 1977), kitchen gardens (Brierley, 1985), household gardens (Vasey, 1985) and dooryard gardens (Lentz, 1993; Works, 1990; Alcorn, 1981); is generally used to describe systems ranging from growing vegetables behind houses to structurally complex multi-storied, multi-output systems.

Most tropical home gardens are classified as agrosilvopastoral systems consisting of herbaceous crop, woody perennial, and animal components while some are agrisilvicultural systems based on the first two types of components but devoid of animals. Home gardens range in size from less than 0.5 to several hectares (Fernandes and Nair, 1990; Budowski, 1985; Ninez, 1985; Allison, 1983) and are located in cleared or semi-cleared areas adjacent to HHs or HH compounds. Management of components is undertaken by family labour (Fernandes and Nair, 1986), primarily women and children in many areas. Outputs are utilized mainly for HH consumption (i.e., food, medicine, fuelwood, building materials, etc..), sale or for exchange. In addition to their utilitarian importance, home gardens also have considerable ornamental value. They provide shade for people and animals, enhance soil quality and mitigate forms of environmental degradation, such as expansive deforestation, soil erosion, reduced fertility and declines in overall diversity

2.1 Home Gardens: Structure and Function

Despite their small average size, home gardens are characterized by high species diversity and by a multi-layered vertical canopy and horizontal placement that suggests an intricate association of plants. At first glance it may appear that home gardens are haphazard arrangements of species that bear more resemblance to a "jungle" than a garden, however, every component generally has a specific place and function.

A simplistic vertical model of home gardens is one consisting of a herbaceous layer near ground level, an intermediate layer and an upper level tree layer. In most cases gardens are more complex than this and are characterized by multi-layering. For example, the herbaceous layer may be divided into two parts, the lower (< 1 m in height) dominated by vegetables and medicinals and the second layer (1 - 3 m in height) consisting of food plants such as cassava, banana, papaya and yams. The intermediate layer, ranging between 5 and 10 m in height, is usually dominated by fruit trees (i.e., cacao, citrus species, etc.). The upper layer can also be divided into two, and possibly more layers. Fully grown timber and fruit trees as well as mature species spared during clearing occupy the layer ranging above 25 m in height, and medium-sized trees dominate the 10 - 20 m layer.

The horizontal distribution of components refers to plant arrangements in multispecies combinations, rooting patterns and general placement of individual species. The spatial arrangement of plants in agroforestry systems vary from dense mixed stands - as in home gardens - to sparsely mixed stands - as in most silvopastoral systems. Moreover, the species can be planted in zones or strips of varying widths for a variety of purposes and outputs (fruits, fodder, fuelwood, fencing and protection, soil conservation, windbreak, etc.) (Nair, 1993). A major consideration in the spatial distribution of species is the extent of plant-to-plant interactions, including the often overlooked effect of rooting patterns. Neighbouring plants will often draw on the same pool of environmental resources at both the above- and below-ground levels, resulting in either positive (sharing) or negative (competitive) effects on the others, thereby affecting the yields of both components (Nair, 1990). Little research has been conducted in regard to rooting patterns and configurations specific to home gardens. However, Nair (1979) found that the horizontal and vertical distributions of root systems in a planted, multi-storey crop combination involved little or no overlapping. The result was a system of positive plant interactions where a more complete utilization of resources was achieved.

Home gardens are dynamic, involving the dimensions of time and space, where the introduction of replacement species should contribute to and not detract from the maintenance of the overall structure and functions of the system.

Functioning primarily as units of food production for home consumption, any surplus from the home garden can be used as a buffer against crop failure, as well as providing seasonal security between harvests of other agricultural crops. Home gardens generally feature relatively low labour and capital-inputs, with minimal dependency on expensive, imported pesticides and fertilizers and they produce "sustained yields with minimal environmental degradation under continuous use" (Stoler,1981). The latter refers to nutrient cycling in the form of tree roots bringing underlying minerals into the topsoil, with fallen leaves providing a protective mulch cover and introducing more humus into the soil, as well as the tree cover preventing erosion (Terra, 1954).

Nair (1985) describes home gardens as a legitimate subdivision of agroforestry, and Gliessman agrees when he states that:

> "The tropical home garden is the agroforestry system that shows the greatest complexity and diversity...The home garden is an integrated ecosystem of humans, plants, animals, soils, and water, with trees playing key roles in both the ecology and management of the system" (Gliessman, 1990).

Traditional home gardens are practical, time-tested systems of continuous production used primarily to sustain and maintain food supplies for family consumption and to increase HH income. However, they are not well understood, both in regard to ecological relationships and to human management strategies.

2.2 Home Gardens: Central America and the Maya

Home gardens are part of a traditional land-use system among Maya peoples of northern Central America, southern Mexico and the Yucatan peninsula, evolving in conjunction with shifting (slash and burn or milpa) cultivation and bush fallow. Research conducted in the Peten (Gomez-Pompa and Kaus, 1990) suggests that home gardens "were one intensive technology that allowed the Mayans to maintain 400 to 500 people/km^2 compared to current population densities in the Peten of only 5 people/km^2." Although archaeological evidence of pre-historic home gardens is rare (Lentz, 1991; Gonzales, 1985; de Lameiras *et al.*, 1979; Puleston, 1978 and 1973; Rojas *et al.*, 1974; Palerm; 1973), it suggests that present day gardens, as well as other agroforestry regimes, "have direct ties to preconquest Lowland Maya systems" (Atran, 1993). Barrera (1980) estimates that "before the Spanish conquest 80% of homegarden shrubs and trees [in the Yucatan] were a product of selection from native elements of the flora by Mayan people" (Rico-Gray *et al.*, 1990). Further, Gomez-Pompa *et al.* (1987) point out that the "Post-classic and colonial stone-wall remains of *pet kot* (home gardens) still enclose high concentrations of useful tree species." This evidence suggests that home gardens are time-tested practices based on the transmission of traditional environmental knowledge (TEK) through generations.

Present day Maya home gardens are concentrated around HHs and consist of multi-storied combinations of numerous woody species in association with herbs, annual and perennial crops and micro-livestock (chickens, pigs, turkeys, ..), all managed on the same piece of land primarily by family labour and specifically by women and girls. Size and shape of gardens varies depending on "how the land was acquired" (Rico-Gray *et al.*, 1990) and further subdivided. For example, at the time a village is established the head of each family may be allocated land for house construction and garden use, land may be further divided between married sons, it could be sold or rented, or married sons could obtain land to establish their own HH. External inputs, especially those requiring a cash outlay, are usually low. Soil fertility is maintained by the natural accumulation of tree litter and the application of organic matter such as HH refuse and manure. The primary functions of Maya home gardens is production for HH consumption - edibles, medicinals, ornamentals, utilitarian and ritual plants (Alcorn, 1981) - and, in some cases, cash income (Gillespie *et al.*, 1993; Rico-Gray *et al.*, 1991; Rico-Gray *et al.*, 1990).

3.0 WOMEN AND AGROFORESTRY

Although research on women's roles in forestry and agroforestry is on the increase (FAO, 1989, 1987; Fortmann and Bruce, 1988; Fortmann and Rocheleau, 1985; Hoskins, 1982, 1979), there are still some knowledge gaps which do not address the specific nature and implications of women's involvement in agroforestry. For example, the role of women in the management and decision making processes related to home garden production is rarely mentioned in the literature. In attempting to focus on the management strategies of indigenous Maya women in Central America, I have noted that literature on this topic is virtually non-existent. Since each Maya HH, and by definition each married woman, has its own home garden this is a serious oversight, especially since literature documenting women's home garden activities exists from other parts of the world, including Asia, Africa and India.

Almost three decades have elapsed since Ester Boserup (1970) documented the role of women in development and twenty years since John Bene (1977) stressed that women, in particular, should benefit from agroforestry research and development. Nevertheless, a great deal of development projects continue to be skewed toward other groups, including rural elites and large land owners, males, and identified community innovators (those people that are the first to want to participate in any new idea or scheme). This approach overlooks the participation of women, poorer people, individuals who are sick, disabled or old and migrants (Abel *et al.*, 1989; Chambers, 1983). Because it was generally assumed that only men were involved in production processes, women were not included in agriculture and forestry extension programs for many years. They were excluded from donor agency funding schemes and were denied equal access to natural resources even though they too have been involved in natural resource management for centuries.

Traditionally, women have been important participants in both the agricultural and forestry components of agroforestry production (Fortmann and Rocheleau, 1985). In recent years women's roles were acknowledged and interest stimulated by literature such as the USAID programming guide entitled "Women in Forestry for Local Community Development" (Hoskins, 1979). In this paper Hoskins was the first to present methods for inclusion of women in community agroforestry projects. Other papers, expounding on similar themes, were rare and often limited to an isolated sentence or paragraph, vaguely mentioning women, trees and gardening. Significantly, a study of 43 World Bank forestry projects (Scott, 1980) pointed to the lack of women's participation in forestry projects when it was determined that only eight of the projects made any specific reference to women (Fortmann and Rocheleau, 1985). In a somewhat positive, yet surprising move, donor agencies played a large part in increasing awareness of women's roles in natural resource production by restructuring their funding regulations to emphasize women in development projects as a requirement for receiving funding.

Fortmann and Rocheleau (1985) suggest that women's involvement, or rather non-involvement until recent years, in agroforestry has been linked to four widely accepted myths regarding the roles and status of women. These are:

Myth 1: Women are housewives and are not heavily involved in agricultural production.

Myth 2: Women are not significantly involved in tree production and use.

Myth 3: Every woman has a husband or is part of a male-headed household.

Myth 4: Women are not influential or active in public affairs.

Increasingly, more literature is being produced that refutes myths one through three and continues to explore myth four (Fortmann and Rocheleau, 1985). Myths one, two and four are examined, at some level, in this study, while myth three is not because there are no female headed households (FHHs) in San Lucas.

In light of the prolific effect that these "myths" have had on past funding of and research into women's roles in agricultural and agroforestry production systems, I sought the answers to several questions while conducting my research:

- Which members of each HH are involved in decision making processes related to home garden structure and function?
- What role do women play in managing home gardens?
- Assuming that women are the principal managers of home gardens, are they also the principal users of home garden outputs?
- What factors affect women's participation in home garden production, and in what way?
- Finally, in what way can, do, or will women be able to influence future home garden management activities as they pertain to overall sustainable subsistence production?

Ezumah and Di Domenico (1995) suggest that "factors which influence gender participation in agricultural production include location, marital status, participation in nonfarm activities, ideologies influencing people's perception of male/female activities, farmers' access to production resources and farm inputs, labour constraints as well as competing demands on people's time." As is the situation with agroforestry systems, these factors are situation specific, involving local cultural, social, economic and environmental factors, although there are some broad generalizations that are accepted. For example, in subsistence-based production systems it is generally women, assisted by their children, who are responsible for preparing HH food, supplying fuel and water, bearing and raising children while continuing "to be responsible for most of the labour input in the planting and harvesting of 'female' crops in the home base" (Ezumah and Di Domenico, 1995). Female crops are typically of the vegetable or root variety of foods raised for subsistence or for local consumption. In contrast, men's crops are more likely to be grain or tree, nonfood and crops raised for market, export (Sachs, 1996) or HH consumption. Regardless of the type of crop being produced, women in most agricultural societies participate in farm labour activities even though they usually have a more restricted role in marketing and more limited ability to mobilize labour and access land for their individual use. It is "women, more often than men, [who] mobilize inter- and intra-household linkages in form of informal labour, to provide labour in separate female enterprises because of the financial constraint in mobilizing hired labour" (Ezumah and Di Domenico, 1995).

Home gardens are an example of a 'womens' enterprise that functions based on inter-intra-household knowledge, labour, exchange of plant materials and marketability of produce. Informal groups of women, usually comprised of members of a woman's extended family, residing in the same or independent HHs, within or outside the boundaries of one village, share garden labour, exchange plant materials and sell or purchase produce from the gardens of their female family members. In San Lucas this pattern prevails. Often women from San Lucas will take seeds, cuttings or fruits when they visit a female relative, whether inter- or intra-community, and they return with similar offerings that have been procured through purchase, exchange or received as a gift.

3.1 Feminist Perspectives: Women's Relationship with Nature

Integral to the examination of women and agroforestry are feminist perspectives related to rural and/or indigenous women. Two perspectives, ecofeminism and feminist environmentalism, are presented and discussed below.

Ecofeminism, a relatively new social movement, encompasses insights and perspectives from liberal, cultural, social and socialist feminism to address relationships between people and the environment (Sachs, 1996; Merchant, 1992). Ecofeminists build on the work of feminist critics of science by recognizing the connection between the domination of women and the domination of nature. Despite the symbolic association between women and the land and the widespread cultural perception of earth as mother, at best estimate, women own only 1% of the world's land (Dankelman and Davidson, 1988). Naturally, land is the farmer's/gardeners' principal asset, which makes it very significant in relation to production systems. Although women produce much of the world's food, they have limited control over, ownership of and access to land. And, as in so many areas of their lives, women's limited access to land is often defined by their relationships to men, specifically by their husbands' or fathers' ownership or access to land (Sachs, 1996). A necessity for production, land also provides collateral for access to credit and other forms of capital. Thus, women's exclusion from landownership limits their access to credit, capital, and other resources (Sachs, 1996; Whatmore, 1991).

Women of different classes, races, localities, ethnicities and nationalities have numerous and varied interactions with nature. Rural women's work, such as gathering fuel, animal fodder and water, cultivating food for their families' subsistence and caring for adults, children and infants places them in a particular relationship with the natural environment. Because of this, Agarwal (1992) suggests that women are "likely to be affected adversely in quite specific ways by environmental degradation. At the same time, in the course of their everyday interactions with nature, they acquire a special knowledge of species varieties and processes of natural regeneration." To take advantage of this special knowledge, Agarwal (1992) proposes the term 'feminist environmentalism' as an alternative to ecofeminism, in an effort to move beyond the symbolic connections between women and nature.

My preference lies with the concepts that embody feminist environmentalism because, in my opinion, ecofeminists go to the extreme in romanticizing women's connections to the environment. In so doing, they fail to recognize that these connections often involve strenuous physical labour, struggles for survival, deprivation (Rao, 1991) and environmental degradation for rural and/or indigenous women. Thus, rural and/or indigenous women are connected to nature through their daily activities in their specific localities, but they are not connected to a pristine nature. Instead, they transform the natural world to provide for human needs.

In my opinion, the underlying foundations of feminist environmentalism coincide nicely with the concepts of agroforestry. For example, feminist environmentalism recognizes that factors, such as locality, class, race, ethnicity and nationality, have an impact on women's activities as they relate to meeting livelihood objectives.

4.0 HOUSEHOLDS AND DECISION MAKING PROCESSES

4.1 Households

Wherever we go in the world there appear to be recognizable domestic groupings of kin with a corporate character and an identity that is recognized in the use of terms like family, house, household, or "those who eat from a common pot" (McC. Netting, 1993). We can say that the HH is a social group universal in human society that it may be seen as "a task-oriented, culturally defined unit" (Carter and Merrill, 1979). HHs are engaged in some combination of "production, distribution (including pooling, sharing, exchange, and consumption), transmission (trusteeship and intergenerational transfer of property), biological and social reproduction, and co-residence (shared activity in constructing, maintaining, and occupying a dwelling)" (Wilk, 1991; Wilk and Netting, 1984). In the case of agroforestry, and specifically home gardens, "the intimate association of gardens with residences, compounds, or kitchens reinforces the role of the household as a labour, management, and consumption unit that derives substantial benefits from what may be a very limited set of resources" (McC. Netting, 1993). This is not to say that the concept of a HH is tied to the 'traditional western' ideal of a nuclear family inhabiting one single dwelling. The concept of HH, as it is presented in this thesis, will refer to a group of people who live together under the same roof, cooperate daily in food production, preparation and consumption and who are primarily responsible for child care and socialization (Wilk, 1983). More than one HH can live in a single building or a single HH can inhabit several connected or spatially dispersed structures (Wilk, 1981a; Goody, 1972) located within a HH compound (a compound consisting of one or more dwellings located in close proximity on an area cleared of bush vegetation, and inhabited by members of the same extended family group).

4.2 Decision Making Processes

Agroforestry, as well as other production systems, is shaped by choices and decisions made by HH members, which are, in turn, highly variable among individuals, reflecting differential access to resources. Chambers and Leach (1989; from Scherr, 1995) have attempted to explain this variability through utilization of the theory of "livelihood strategies" in which they propose that emphasis be placed on farmers' objectives as "welfare (utility) maximizers" rather than assuming that all farmers are "profit-maximizers." In essence, the livelihood strategies theory proposes that individuals, although functioning within a larger HH unit, have multiple objectives, including "secure provision of food and essential subsistence goods, cash for purchase of outside goods and services, savings (resources accumulated to meet future planned needs or emergencies), and social security (i.e., secure access to subsistence goods and productive resources such as land)" (Scherr, 1995). Individuals within a HH select "livelihood strategies" (including different agroforestry strategies) that will enable them to fulfill of their objectives by utilizing accessible resources (on- and off-farm lands, trees, labour, cash), while reducing critical risk factors.

Since natural systems and HHs are dynamic it should also be understood that both available "resources and livelihood objectives change over the life cycle of the [HH]" (Scherr, 1995). Given this dynamism, it seems probable that farmers would be more likely to adopt agroforestry practices which provide returns to HHs that are superior to available alternatives, or which meet their objectives more cost-effectively than alternative options. Increasing yields-per-hectare (Raintree, 1983) and financial profitability are often assumed to be the main incentives for farmers' to modify their existing production activities. However, Scherr (1995) found that potential risk to individuals and HHs, rather than profitability, was integral in any discussion of decision making among subsistence farmers. The probable explanation for this rests with the subsistence farmers' need to ensure minimum yields, at the very least, to be used for family maintenance. One possible consequence of this reasoning may be that farmers will choose not to adopt strategies (i.e., multi-year agroforestry production cycles) that present them with potential cash flow problems, increased labour requirements and "carry the risk that there may be no harvest in the end, due to theft, damage, or tenure insecurity" (Scherr, 1995). This is, perhaps, where investment in home gardens may be preferred to other agroforestry practices. Based on the discussion above it seems probable that home gardens could be viewed as a positive risk because they are low-input (cash, labour, capital goods), low-maintenance systems that also present less of a problem with security due to their location adjacent the HHs.

The risk associated with the acceptance of new agroforestry strategies could be minimized through "gradual adoption and adaptation of new practices, and cost- and risk-reducing modifications in technology design" (Scherr, 1995). In essence, the initial period of establishment is the riskiest part of the process involved in the decision to adopt new agroforestry practices. Once established, farmers can readily see the benefits produced by agroforestry systems, such as diminishing farm risk by reducing wind damage or soil erosion, providing supplemental sources of food during drought, or providing standing timber assets to be sold for cash in an emergency (Scherr, 1995).

Non-economic, as well as economic factors are taken into consideration when individuals or all members of a HH are making decisions. Scherr (1995) found that "improvements in the quality of the human environment (ornamental and shade trees, wind protection for the homestead, a more attractive landscape) were important to many farmers." While conducting my own research, both women and men, referred to some plants as "pretty" and stated that these were spared and/or encouraged to grow because they "make the place look nice."

4.3 Women's Role in Decision Making

The role of women in making decisions regarding agroforestry systems varies based on the factors suggested by Ezumah and Di Domenico (1995): "location, marital status, participation in nonfarm activities, ideologies influencing people's perception of male/female activities, farmers' access to production resources and farm inputs, labour constraints as well as competing demands on people's time", in combination with the livelihood objectives of each woman. For example, the Kekchi Maya women residing in San Lucas are generally responsible for supplying the HH with fuel and water on a daily basis, preparing and cooking food and also for the bearing and raising children. Women's livelihood objectives emphasize strategies for the production of food and utilitarian items for the maintenance of HHs. Men in the community are concerned not only with subsistence production, but also with commercial production providing cash income. These differences in livelihood objectives are reflected in home garden structure and function. Through a variety of methods women obtain seeds, seedlings and/or cuttings of species to be added to the home garden, they decide which existing species will be spared during clearing and they decide where garden additions will be located.

Outputs from home gardens may be divided into four broad categories: for HH use, for exchange, for cash income or for ornamental appeal. With few exceptions, women manage and harvest the majority of home garden plants and they decide what will be done with harvested products. Any cash income derived from the sale of home garden produce may be controlled by the woman alone, by the male head of the HH or by the couple together. This depends upon the HH and cannot be said to be uniform throughout all of the HHs in San Lucas. Additionally, women "whose husbands worked away from the village have more management autonomy (subject to being so authorized by their husbands) than women with husbands at home" (Scherr, 1995). For example, one woman in San Lucas cultivates a large number of plantains in her home garden in comparison with other women in the village. Most of the produce is destined for sale in other villages or at the district market. However, this commercial production takes place in addition to the cultivation of customary home garden species. Therefore, it can be said that livelihood strategies selected to meet the objectives of this HH are similar to, and yet differ from those selected by other HHs.

5.0 TRADITIONAL ENVIRONMENTAL KNOWLEDGE (TEK)

As presented above, the elements of profitability, risk and improvements in the quality of the human environment combine to influence livelihood strategies selected by individuals and HHs. Another factor influencing selection of strategies is knowledge, specifically traditional environmental or ecological knowledge (TEK), generally defined as:

> "...a body of knowledge built up by a group of people through generations of living in close contact with nature. It includes a system of classification, a set of empirical observations about the local environment, and a system of self-management that governs resource use. The quantity and quality of traditional environmental knowledge varies among community members, depending upon gender, age, social status, intellectual capability, and profession (hunter, spiritual leader, healer, etc.). With its roots firmly in the past, traditional environmental knowledge is both cumulative and dynamic, building upon the experience of earlier generations and adapting to the new technological and socioeconomic changes of the present" (Johnson, 1992).

Although not the only modern term used to describe ethnoscientific knowledge, TEK seems to be the most appropriate in regard to the subject of this study. TEK "attempts to interpret traditional knowledge within the framework of local ideology and social controls [rather than] in isolation from its specific socio-cultural context" (Cotton, 1996). Similar terms used to describe ethnoscientific knowledge, such as indigenous technical knowledge (ITK), indigenous agricultural knowledge (IAK) and traditional botanical knowledge (TBK) to name a few, are presented, defined and discussed at length in Cotton (1996) and will not be expanded upon here.

The following is a list of general attributes of TEK taken from Johnson (1992). It should be noted that not all of the following are applicable to every situation:

- TEK is recorded and transmitted through oral tradition (often through stories).
- TEK is learned through observations and hands-on experience.
- TEK is holistic in that all environmental elements are viewed as interconnected and cannot be understood in isolation.
- TEK is mainly qualitative and knowledge is gained through ongoing intimate contact with the resource.
- TEK is based on data generated by resource users and as such is more inclusive than Western science, which tends to be selective in the collection of facts/data.
- TEK is based on a long time series of information focusing on one locality.
- TEK explanations of the environment are based on cumulative, collective experience. It is checked, validated, and revised daily and seasonally through the annual cycle of activities.

This list of general attributes, in combination with archaeological evidence from Central America, suggests that Maya home gardens are part of a "landuse tradition" (Raintree, 1983) that is time-tested and based on the accumulation and transmission of traditional environmental knowledge (TEK) through generations. This "landuse tradition" provides individuals and HH units with an advantage when moving from one area to another. Provided environmental conditions are similar between the areas of current and previous residence, the time required for farmers/gardeners to adapt to a new area may be reduced since experimentation with production variables (i.e., growth habits of specific plants, allelopathic tendencies, soil differences, etc.) is not immediately necessary. Further, it is possible that methods of intensifying production, usually in response to land pressure (Boserup, 1965) may be more easily implemented among people who possess TEK because they are familiar with the potential, limitations and risks associated with the cultivation of certain plant species under specific environmental conditions.

It remains for development professionals and extension personnel to learn that TEK is "neither static nor uniform as is often assumed, but is generated, maintained and modified according to local ideology, external social or practical influences and changing resource availability" (Cotton, 1996). An increased understanding of the nature and dynamics of different knowledge systems should facilitate greater and more effective cross-cultural communication in the future (Merculieff, 1994), a key element in the development of collaborative and sustainable programs of resource management.

Although potentially useful for resource management, critics of TEK focus mainly on the idea that, although TEK may have been impressive in its earlier forms (as attested to by archaeological evidence), it is dwindling in importance as indigenous peoples are being assimilated into Western culture and by the failure of individuals with knowledge to pass it on to younger generations. Certainly, some erosion of TEK has no doubt occurred. However, a significant element of TEK still exists within indigenous communities that continue to exist in relative isolation as a result of inadequate infrastructure, or by choice. In a study of Maya home gardens from the Yucatan peninsula Rico-Gray (*et al.*, 1990) suggests that it is probable that subsistence producers who live further from an economic centre and the influence of western technology (i.e., pesticides, improved seed and livestock, education programs, etc.) rely, to a greater degree, on their TEK for ensuring production levels necessary to support their families. Conversely, producers who live closer to, and have greater accessibility to an economic centre are more closely tied to the marketplace, placing lesser reliance on TEK for subsistence production than their counterparts who live further away. A similar pattern is easily discernible throughout Maya villages in the study area in southern Belize.

In fact, Rico-Gray (*et al.*, 1990) states that in the Yucatan they "noticed a trend towards a change in homegarden structure and function in response to the modernization process. Homegardens in villages in the outskirts of cities tend to have more ornamental species and commercial fruit plants than homegardens in isolated villages."

CHAPTER FOUR

IV. THE MAYA: LAND AND LABOUR IN SOUTHERN BELIZE

1.0 THE KEKCHI MAYA: HISTORY OF SETTLEMENT

"The Kekchi are a Maya-speaking group numbering over 400,000 in eastern Guatemala and adjoining parts of Belize. Though predominantly a highland people, they have interacted with, and colonized, adjacent lowland areas for at least the last 200 years" (Wilk, 1983, 1981a; King, 1974).

Little is known about the Kekchi from pre-Hispanic times. The earliest references arise in the 1500s during the early stages of the Spanish conquest of the "New World." Spanish accounts indicate that the Kekchi inhabited the highlands of the Department of Alta Verapaz, Guatemala, "although they probably always moved between the highlands and the lowlands, as they do today, colonizing rainforests of Peten and Izabal in Guatemala and moving into southern Belize" (Wilk, 1991; Schwartz, 1987). However, during the colonial period many Kekchi people fled from the oppressive control of the Dominicans Friars in the Guatemalan highlands to the sparsely populated lowland forests to the north and east of the Alta Verapaz. The sparse population of the lowland rainforests, specifically those in southern Belize, can be attributed to Spanish conquerors who shipped the resident Maya inhabitants off to the Guatemalan highlands to work as labourers in the 1600s (Wilk, 1991). Accounts of English corsairs kidnapping Indians from the Temash River area [Toledo District] in 1677 (Wilk, 1991; Thompson, 1972) confirm that some Maya continued to reside in southern Belize;

although it is not known if these Indians were Kekchi Maya or from another Maya group.

Later accounts indicate that a major influx of Kekchi Maya into southern Belize occurred between 1881 and 1890 when many families were relocated from Alta Verapaz to work as plantation labourers in San Pedro Sarstoon, located close to Guatemala in the southwestern corner of Belize. Also during this time period, reports indicated that Kekchi and Mopan Maya "planned and organized a migration across the border into Toledo District, to escape taxation and forced labour" in Guatemala (Wilk, 1991). The most substantial increase in the Kekchi population of southern Belize occurred in the 1970s, when mining and cattle ranching operations expanded into Kekchi territory on the Guatemalan side of the border, resulting in dramatic increases in political and economic oppression of Indians (Wilk, 1991). That situation, in combination with availability of agricultural land in southern Belize, prompted many Kekchi to cross the border.

Although regular census figures have only been available for Toledo in recent years, the following demonstrate a steady, and sometimes punctuated, increase in Kekchi inhabitants.

Table 4.1 Kekchi Maya Population Figures and Average Annual Growth Rate, Toledo District

Year	Population	Average Growth Rate
1886	0	
1921	1,300	37 individuals
1980	3,664	
1991	7,122	314 individuals

Average Growth Rate refers to the average number of individuals added to the total population each year.
CSO, 1994; Wilk, 1991; BHAR, 1891.

Groups and individual families continued to immigrate to southern Belize from Guatemala, establishing new villages and moving into existing villages. Most movement of individual HHs takes a stepwise form similar to that found in the Peten by Adams (1965). This means that a HH will settle for several years in villages along a route, usually where kinship ties exist, and then move on to the next village after some sort of kinship tie has been established. As a consequence, kinship ties link people inhabiting the villages along the migration routes, often with people moving in both directions through marriage (Wilk, 1991).

It should not be assumed that Kekchi Maya population movements in Toledo District are only a consequence of linear migration from Guatemala. The reality is that intervillage mobility, village fissioning, northward movement and resettlement has dominated Kekchi history in southern Belize. Villages, HHs, and individuals move in response to land pressure and utility, opportunities for wage labour, access to markets for crops, development projects and incentives, kinship alliances (i.e., marriage) and village politics (i.e., feuds) (Wilk, 1991). The Kekchi Maya village of San Lucas, for example, was one of the largest villages in the area in the 1960s, but was abandoned in favour of wage labour opportunities in the village of Crique Sarco. Some of the original inhabitants returned and have since united with new HHs to re-establish the village adjacent to a recently (1980s) constructed dirt road linking the south with the district capital of Punta Gorda. Another example is that of the Kekchi village of Santa Theresa, which was established on the site of an abandoned logging camp in 1932. In the 1950s, the entire village of Santa Theresa moved north to a site two miles away from the mixed Mopan/Kekchi Maya village of San Pedro Columbia. The latter move occurred because the Government of Belize (GOB) promised to build a road "connecting the new site, San Miguel, with San Pedro Columbia, the latter of which already had access to the Punta Gorda-San Antonio road. Half of the original San Miguel inhabitants returned to Santa Theresa" (Berte, 1983).

2.0 MAYA LAND-USE SYSTEMS: TOLEDO DISTRICT, BELIZE, C.A.

Maya land-use systems in Toledo District may be divided into two broad categories:

- land under agriculture, including the traditional form of agricultural subsistence production known as milpa, slash and burn or swidden; permanent cropping (i.e., orange, cacao, etc..) and agroforestry systems.
- land under forestry plantations (i.e., mahogany, pine and *Gmelina* planted on Crown land).

Milpa refers to the cultivation of maize, beans, ground foods and more recently rice monocultures, while agroforestry refers to combinations of trees with crops and/or animals. Among the Maya neither agroforestry nor milpa are exclusive, rather, a certain amount of overlap does exist between them.

Land-use figures from 1970 and 1985 (Table 2.1, page 14), indicate that over this 15 year period an increase of approximately 61% in agricultural activity took place in Toledo District, mainly in the villages in the northern area of settlement (King *et al.*, 1986). More current figures were not available at the time this research was conducted.

2.1 Milpa Agriculture

Milpa production, which may also be described as slash and burn or shifting cultivation, generally relates to cultivation of subsistence quantities of maize, beans and ground foods as well as the production of cash crops such as rice and beans. The milpa system combines a number of activities: social, religious, economic and agricultural. All of these are closely interrelated so that is not simply an agricultural system but more a way of life.

The Maya cultivate their principal crop of maize during the wet season, between May and November. Subsequent to the harvest of wet season maize, a crop of black beans is planted in the same milpa, followed by a fallow period of approximately 7 years (Wilk, 1991; Johnson, 1986; King *et al.*, 1986; Seager, 1983) before another maize crop is cultivated at that location. This fallow period is meant to permit the recovery of the fertility and structure of the milpa, as well as to control pervasive grasses. Ideally, a fallow period should last until such time as the vegetation cover had reached maturity (i.e., 30 + years); however, the effects of land pressure are such that changes in human population levels have a corresponding effect on fallow lengths, often resulting in shorter fallow periods. For example, when land pressure is low there are large areas of well-fallowed land available and vice versa. For most Maya farmers in southern Belize "a fallow length of 15 years or more strains the human memory" (Wilk, 1991).

The initial cropping cycle begins with the felling and burning of mature forest, or high bush as it is termed by the Maya. Maize, the staple food crop of the Maya, is cultivated in the wet season between April/May and November, while a secondary crop of maize, called *matahambre*, is produced during the drier months between November and March. The *matahambre* crop is produced on the same plot each year using a system of natural vegetative mulch (chopping and mulching), rather than slashing and burning, which permits cultivation without the need for intermediary fallow.

Rice milpas are generally cultivated in low-lying areas where seasonal flooding occurs, with one, and sometimes several, crops being harvested during any single wet season.

Black beans and red kidney beans are also cultivated in separate milpas, the latter when seed is available. Additionally, a selection of ground foods consisting of cassava, yams, yampi, dasheen, sweet potato, etc.., are intercropped into wet season maize milpas, as well as being cultivated in separate milpas. While beans are both consumed and sold for cash, ground foods are produced solely for domestic consumption.

The steps involved in milpa production have been identified in detail in several sources (Atran, 1993; Wilk, 1991; Harrison and Turner, 1978; Ashcroft, 1973; Carter, 1969) and will not be repeated here.

2.2 Agroforestry Practices

- home gardens
- plantation crop combinations: milpa gardens
- multipurpose trees on crop lands
- improved fallow

2.2.1. Home Gardens

Home gardens occupy those areas adjacent to a family HH and compound where components are arranged in intimate, multistory combinations of various trees and crops; predominately fruit trees, other woody species, and shade tolerant agricultural species. Small domestic animals, such as chickens, turkeys, ducks and pigs, are also reared in most Maya home gardens. Gardens are usually managed by women, girls and younger children. The species found within these gardens function as reserves of fresh fruit, food for domestic animals, boundaries between HHs, repositories of medicinal and culinary plants, ornamentals, etc. and, more recently, cash crops. The latter category, cash crops, has increased in size and apparent importance over the past few years [my observation] and seem to be mainly the addition of male heads of HHs.

2.2.2 Plantation Crop Combinations: Milpa Gardens

Milpa gardens are cultivated away from the HH, on a portion of the same land that a family had previously used for a maize milpa. After maize cultivation fields are commonly left to fallow, utilized for gardens, planted with ground foods, a combination of all three, or fallow vegetation may be chopped and burned after a year or two and a garden planted.

Much larger than home gardens, milpa gardens have a higher diversity of species; but usually contain fewer large woody species, such as fruit trees. For example, milpa gardens commonly contain: garlic, onions, native tomato, chayote, sweet potato, peppers, callaloo, okra, squash, papaya, palm, sugarcane, pineapple, cassava and other ground foods, banana, plantain and maize (interplanted to fill in spaces where other plants did not germinate). Many of these species do not appear in home gardens which may, or may not, contain more large woody species, such as fruit trees. The reasons for establishing two garden types range from the knowledge that domestic animals will destroy ground level crops near the HH, to the wish to keep the area around the HH clear from low growing plants in the event that snakes come near the house.

2.2.3 Multipurpose Trees

Multipurpose trees on crop lands are characterized by a seemingly random arrangement of woody perennials that are left around milpa/field boundaries (Nair, 1993) and in forested areas. These trees, as indicated by the term multipurpose, can be utilized for their fruits (food and market produce), sap (incense), bark (medicine), leaves (spices and medicine), as fuelwood, as lumber, as building material, etc..

2.2.4 Improved Fallow

Improved fallow, as defined by Nair (1993), is characterized by woody species, preferably leguminous, that are planted and left to grow during the 'fallow phase' of production. Maya subsistence farmers leave fallow areas to be naturally reclaimed by forest species, in combination with planting ground foods and woody perennials following cessation of maize and bean production. In the latter situation, ground foods, plantain, banana, squash, etc., are generally cultivated for up to three years after maize production. Crops and products from woody perennials continue to be harvested from these areas after true fallow conditions, indicated by the continuous invasion of native forest species, are permitted to occur. For example, fallowed areas produce cassava, squash, papaya, banana, plantain, palm and other crops due to regeneration by roots, scattered seeds, deserted seedlings, species invasion and deliberate plantings by farmers. An additional benefit of improving fallow conditions is that game animals, as presented below, are inclined to forage in disturbed and previously cultivated areas; thereby, providing a rich source of meat protein for villagers to utilize.

Table 4.2 Animals Invading the Milpa/Hunted	
Common Name	Scientific Name
Coati, Quash	*Nasua nasua*
White-tailed deer, deer	*Odocoileus virginiana*
Red brocket deer, antelope	*Mazama americana*
Collared peccary, pecari	*Dicotyles tajacu*
Paca, Gibnut	*Agouti paca*
Agouti	*Dasyprocta punctata*

3.0 KEKCHI MAYA LAND TENURE AND ACCESS IN TOLEDO DISTRICT

Three official types of land tenure are available to residents of Toledo District: (1) communal holdings on established Indian Reserves, (2) outright ownership obtained by purchasing land and (3) leasing land from the GOB. All involve annual fees to the GOB, in the form of taxes or lease payments.

Land tenure among the Kekchi Maya is, in most cases, based on usufructuary rights to use land within the boundary of a government sanctioned Maya Indian Reserve. In 1924, officials of the government of British Honduras (now Belize), under the Crown Lands Act, implemented a system whereby each recognized Indian village was granted an Indian Reserve, where community members could live and farm under an elected village mayor (*alcalde*) (Wilk, 1991; Bolland, 1987). Initially, an *alcalde* was appointed to each Reserve; elections to take place bi-annually thereafter; who was responsible for collecting an annual fee of $5.00 Belize - a significant sum at the time - from each farming family as payment for land used. In 1933 amendments were made to include Maya villages that had been missed in 1924, resulting in the current total of twelve Maya Indian Reserves (Figure 4.1, page 50) and the original one Black Carib (Garifuna) Reserve. Notably, Maya Indian Reserves were established in Toledo District, and modeled after a similar system imposed on Maya Indians of the Yucatan,

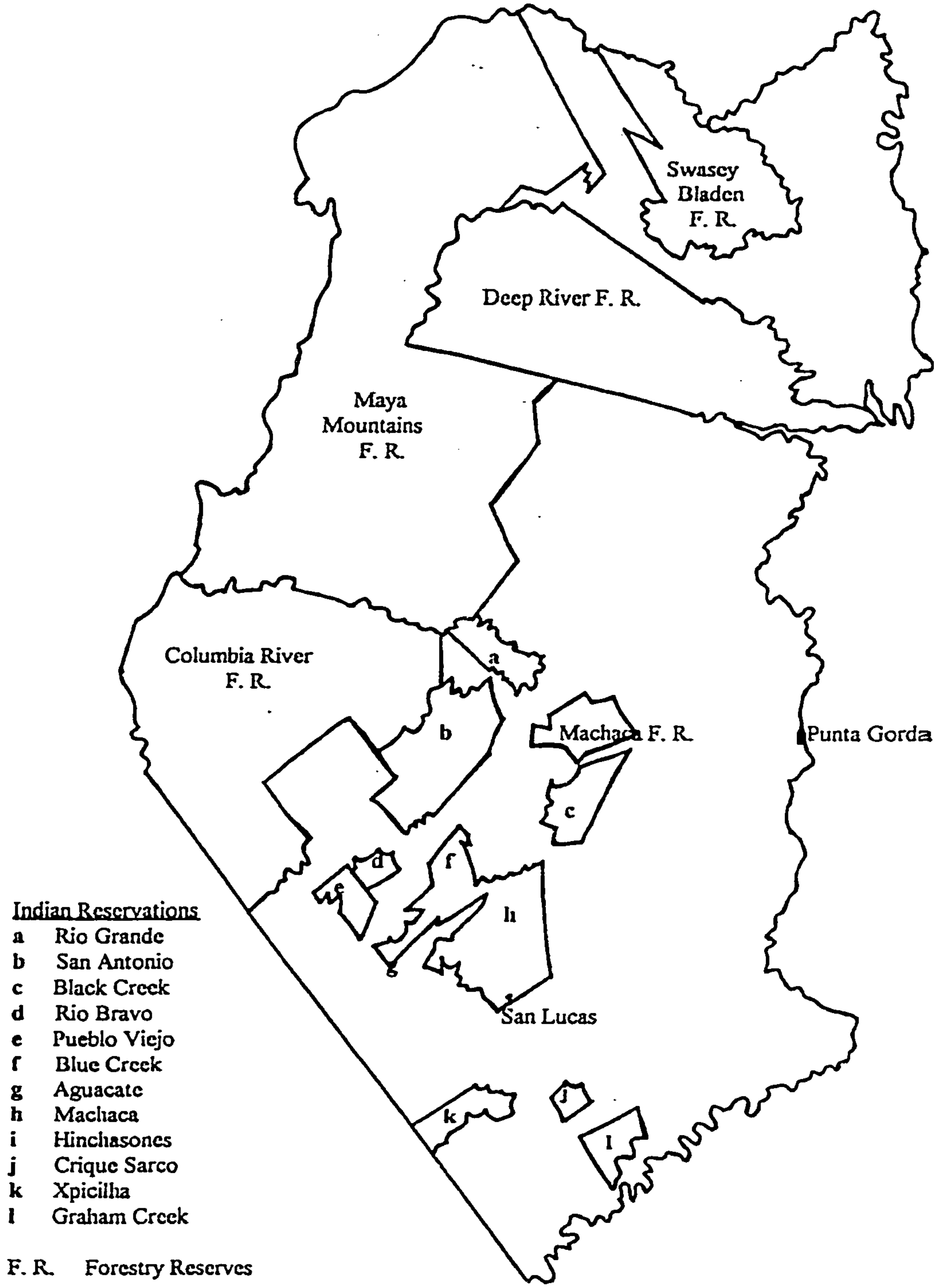


Figure 4.1 Maya Indian Reserves and Forest Reserves, Toledo District, Belize.

Source: Modified from King *et al.*, 1986.

in response to farmers' defaulting on land taxes and lapsing on lease payments and renewals (Wilk, 1991). The government of the time established the Reserve system, with its imposed *alcalde* leadership, in order to force the Maya into nucleated communities which, from an administrative point of view, would facilitate collection of fees. Earlier forms of Kekchi Maya land-use - possibly in the form of widely disbursed HHs, and/or HH clusters, and agricultural plots, a pattern common among shifting agriculturists throughout Central (Nations and Nigh, 1980) and South America - and mechanisms for allocation, are not known. However, it would be interesting to see what type of tenure system the Kekchi themselves would utilize if given the opportunity to choose.

Although the original intent of the Reserve system was to provide a land base for each recognized Maya community the current reality is that more than one village may exist within an acknowledged Indian Reserve and also overlap onto adjoining Crown Land. Demarcation of communal territory occurs between neighbouring communities, rather than by government decree, so that the members of each settlement have access to various types of resource zones.

The most extensive Reserve holdings are those of the Maya, officially encompassing an area of approximately 77,000 acres (Figure 4.1, page 50). In terms of actual land-use, the Toledo Maya Cultural Council (TMCC), in 1996, cited a figure in the area of 500,000 acres. TMCC, a group of Kekchi and Mopan Maya leaders, are pressuring the GOB to have Maya Indian Reserves officially enlarged to reflect "actual land utilized" by Maya farmers. Indeed, Maya farmers' encroachment onto Crown Land, including Forest Reserves (Figure 4.1, page 50) has, in recent years, increased in the northern portion of Toledo District in response to the growing population and simultaneous spatial demands of the traditional milpa (slash and burn) system of farming.

3.1 Individual and Household Access to Land

It is common for Kekchi families to move from village to village, primarily within Toledo District; as well as from Guatemalan Maya villages to Belizean Maya villages. Upon entering a new community a family must obtain permission from the village council to remain in the settlement. This can be a very important decision, especially in a situation where land pressure is becoming a problem and where topography (i.e., hills with steep slopes) limits the amount of land suitable for agricultural pursuits. Once a family is accepted into a village they are allocated land for production and settlement purposes.

Within each community, male heads of HHs and single men who are cultivating milpas, are allocated land for milpa production, forest extraction and a HH compound. Women have access to land only through their fathers, husbands or children. Theoretically, the *alcalde* of each community is not only responsible for collecting government lease payments, but also for allotting land to community members. In practice, the latter task is more often undertaken in collaboration with village council members, consisting of men holding the positions of *alcalde*, second *alcalde* and chairman.

Land is not owned in the sense that individuals hold legal title; however, males retain a type of *de facto* 'ownership' of milpa land provided they were the first to clear and burn the area for planting maize. This gives a man the right to utilize that piece of land in the future, whether for subsequent crops or fallow production. Further, men retain the right to forested areas as long as their family is using the area for extractive purposes (i.e., collection of copal incense, medicines and leaves for spices; hunting; procurement of building materials, etc.).

Home gardens, as part of a HH compound, are considered 'property' in a different way. A man may sell, rent or loan his HH compound to another man or family provided that the village council agrees to admit that man and/or family into the community. Prices vary for HH compounds, often depending upon the level of development and the location relative to a source of water or some other desirable natural resource. For example, a compound with two houses and several hundred mature economic tree species (cacao), adjacent to a perennial water supply, was purchased by a Kekchi family moving to the village of San Lucas for approximately $1,500.00 Belize (equivalent to $750.00 US).

Young, unmarried men usually work their father's land; however, at an age somewhere between 14 and 16 years young men usually seek to secure their own milpa land within the boundaries of the village lands. Obtaining productive land permits a young man to prepare for marriage by working his own milpas; however, his obligation to work his fathers land (in addition to his own land) does not terminate until he either marries and establishes his own HH or moves into the house of his in-laws. In the village of San Lucas some of the young men have married Guatemalan women and remain in their fathers HHs until such time as they are able to establish their own. Alternatively, young married men occasionally practice matri-local residence, living with their in-laws, while assisting with subsistence activities for the entire family while establishing their own milpas and HHs. The latter situation occurs when the bride comes from a family of all girl children, if her brothers are young and not able to assist their father in the milpa, or if the father is influential within the village and would be able to assist the young couple in establishing their own HH. Naturally, the conditions of residence vary widely depending upon individual and/or family circumstances.

3.2 Women: Access to Land

Maya - both Kekchi and Mopan - women who live within the boundaries of an Indian Reserve in Toledo District are not officially allocated land for production or any other purpose. As is the case with Igbo women in Nigeria, Kekchi "women have use rights (usufructuary rights) to land through their husbands, fathers, brothers and sons" (Ezumah and Di Domenico, 1995); the latter occurring usually if she is older and widowed. Although Kekchi women are responsible for home garden management, daily HH operations, rearing children, forest resource extraction, milpa production, handicraft production, etc., they are not recognized as property owners under the current communal land system. This system has not been revised since 1932 when additional villages were added to the Reserve land occupied by the Toledo District Maya, but rules governing individual access and use rights remained the same.

Further, although women manage home gardens, decisions regarding disposal of these gardens in the event that the family decides to move to a new location, either temporarily or permanently, is made by both husband and wife, or by the husband alone. Decision making of this type varies between HHs. The male head of the HH, usually the husband, receives payment for the HH compound/home garden, although utilization of the money may be decided jointly by both the husband and wife. Depending upon the family circumstances, a husband and wife may discuss options and make joint decisions in regard to disposal or acquisition of property or resources such as HH compounds/home gardens.

4.0 LABOUR AMONG THE KEKCHI MAYA

There are several types of formal labour groups identified among the Kekchi. Each operate under a distinct, yet flexible set of rules based on exchange and reciprocity. Also, a gender-based division of labour exists under which most agricultural tasks are the exclusive activity of men, while most domestic tasks, including food processing and preparation, are exclusive to women. In between are a number of tasks not prescribed to either males or females, where there is room for negotiation and choice. Further, the labour of any male residing in each HH is at the disposal of the male head of HH, and female labour is similarly under the control of the female head of HH (Wilk, 1991).

4.1 Women and Labour

Women form work groups of various kinds. For example, several women may rotate child-care duties (for toddlers and older children) so that others will be free to conduct other tasks that take them out of the house (i.e., trips to the milpa to plant or harvest, trips to the forest to collect copal incense, or trips to other villages to visit relatives and friends). This reciprocal form of labour exchange often emulates kinship ties with groups of sisters, cousins, daughter and mothers participating. Although women spend a great deal of time engaged in activities related to HH maintenance (i.e., maintaining the home garden, preparing food and child-rearing), they do not exchange labour between HHs for activities related to home garden maintenance. Home gardens are the domain of the female head of HH and any females residing in her house whose labour she controls.

Women also do varying amounts of agricultural work. For example, women may "visit the fields two or more times a month and help plant vegetables, gather wild food, harvest, and carry firewood and corn, and other food, home" (Wilk, 1991). The number of trips women will make outside the village to conduct these activities varies between villages and HHs. In fact, Wilk (1991) suggests that "there is a clear trend toward less female participation in farming in the northern zone near the highway."

4.2 Agricultural Labour

The majority of all agricultural labour in Kekchi villages is family labour. Groups composed of male members of different HHs can range from two to the entire adult male population of the village. Generally, men rely first on their brothers, fathers, sons and sons-in-law to assist with major agricultural tasks such as clearing land, planting and harvesting. If, however, a man does not have adult sons, sons-in-law or other male relatives in the village or near by he will participate in a communal labour group in which the group works in each member's field on successive days in rotation. In other words, men who participate in a work group are obligated to do the equivalent amount of work in the fields of other group members. Generally, communal labour groups are formed for major tasks, such as clearing new milpa fields and planting activities. These communal work groups function when all villagers have the same task to do at the same time (i.e., planting corn or beans), thereby ensuring that all men are participating in equivalent tasks. For example, most farmers would agree that a day spent building a corn house is not equivalent to the much harder task of chopping low bush.

Other activities related to milpa production, such as application of pesticides and herbicides, replanting, preparation and storage of crops, are performed by individual farmers and members of their immediate families.

Individual exchange groups also occur when a man borrows labour from several men and pays back that day to each man later. These groups are the most flexible, but can lead to all kinds of hanging labour debts that many people prefer to avoid.

During agricultural peaks, or bottlenecks, labourers are occasionally hired to assist with such activities as initial clearing of milpa fields and harvesting of cash crops (i.e., beans and rice) and maize, the staple food of the villagers. Labourers are readily found among the population of young men from other Maya villages in Belize that do not, as yet, have their own milpas and Guatemalan Maya. An average of $10.00 Belize dollars is paid to each labourer per 'task' cleared or harvested. In this instance a 'task' refers to a native measure of land that is equivalent to a Spanish *mecate* (a 25 x 25 foot space). Another form of wage labour involves community members who own horses and for $1.00 per 100 pound bag will transport produce from milpa fields to the village.

CHAPTER FIVE

V. THE STUDY AREA AND METHODS

1.0 THE STUDY AREA: SITUATION

The study area is located in Toledo District, the southernmost political division in Belize. Encompassing an area of 4,421 square kilometers, or 19% of the nations land mass, Toledo District is approximately 95 kms in length and 40 kms in width. The village of San Lucas is situated inland, in the mid-western lowlands bordering the foothills to the south of the Maya Mountains (Figure 1.1, page 2). The Kekchi Maya generally establish their villages in the lowland region because they have access to better drained upland soils, or near small ranges of limestone hills out on the plain. The village of San Lucas, and it's adjacent resource management zones are located in a portion of the lowland region that is characterized by low and medium karst, intermingled with areas of low-lying plains. The low karst areas and the basins between the towers in the medium karst areas are the principal areas where traditional milpa agriculture, also known as slash-and-burn or shifting cultivation, is practiced. Medium karst towers remain under forest cover, thereby decreasing the possibility of wind and water eroding the soils, and are utilized by the villagers for extraction of naturally occurring substances for use as building materials, incense, spices, etc...

1.1 Climate

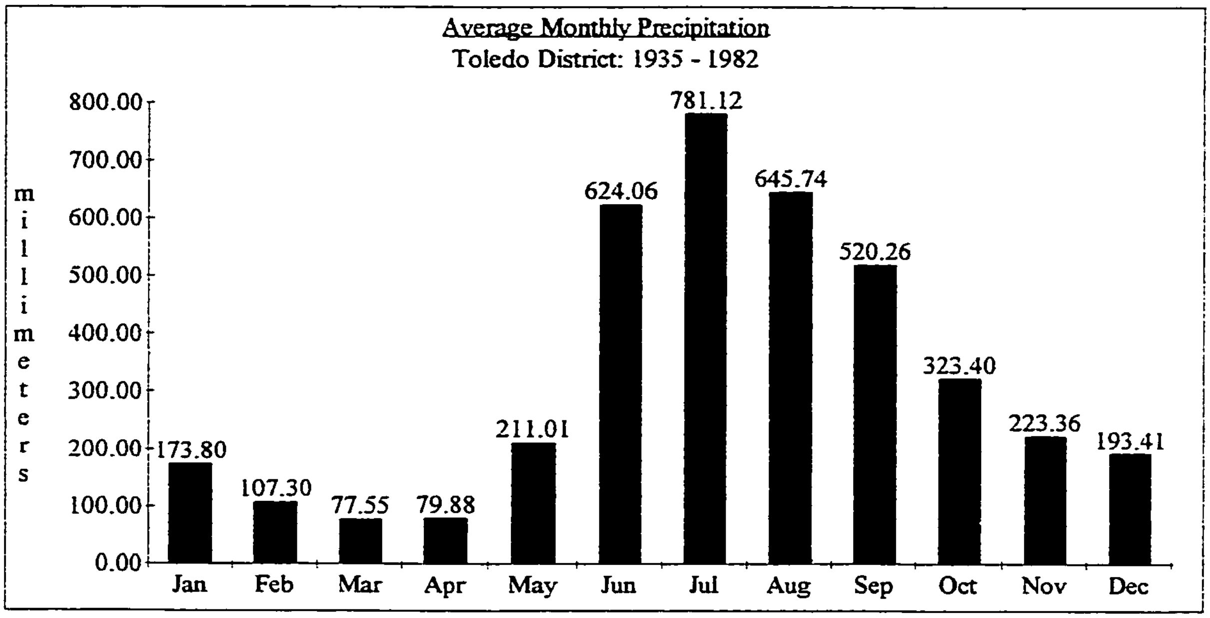
Toledo District, and Belize as a whole, is located in what is widely referred to as "the tropics", a part of the world located between 23.5 degrees north and south of the

Equator. "The major climatic parameters that determine the environment of a location in the tropics are rainfall (quantity and distribution) and temperature regimes" (Nair, 1993). Altitude is also important because of its influence on temperature and landform features. Of the major ecological regions recognized in the FAO State of Food and Agriculture Reports (SOFA), two are relevant to the study area: subhumid tropical (lowland) and humid tropical (lowland). Together referred to as the humid tropics, these lowland regions generally fall between sea level and 800 m in elevation and are characterized as :

> "Hot, humid for all or most of the year, rainfall > 1,000 mm; sometimes one or more extended dry periods per year; Koppen Af, Am and some Aw, especially Aw" (Nair, 1993 and 1989).

The average annual temperature in Toledo District is generally greater than 24 degrees Celsius (C), with no more than one month when evaporation exceeds precipitation. The mean annual rainfall can vary significantly from place to place within the district and ranges from 2,500 mm to 4,400 mm (King *et al.*, 1986). In a typical year the wet season lasts from May through December/January, with a peak in precipitation occurring in the month of July (Figure 5.1, page 60). About 10 percent of the annual precipitation falls in the dry season, January through May (King *et al.*, 1986). The district is economically and physically isolated from the rest of the country by wet season flooding that makes highway travel to and from the area difficult to impossible, as well as by the high costs for shipment of commercial exports and imported food items. Agricultural activities in Toledo District are limited to subsistence and some commercial production, mainly of citrus and banana.

Figure 5.1



Data derived from daily precipitation records collected at the Toledo District Agriculture Station. All monthly values are given in millimeters.

1.2 Geology, Landforms and Hydrology

Toledo District is naturally divided into two areas - upland and lowland. The district is basically the remnant of a flat shelf of hard, white Jurassic limestone that has been folded, faulted, eroded, and then partially covered by mixed, softer Eocene sediments called the Toledo beds (Romney, 1959). Uplift and erosion have produced a complex karst landscape characterized by a rugged inland area that is bordered by a low, flat coastal shelf. In the lowland area of the district the Toledo beds form a flat layer which is pierced by underlying limestones that jut upward to form very steeply sloped, rugged ranges of hills interspersed with plains. In the uplands the underlying limestones are covered by the Toledo beds, the combination of which forms a gentler and more rounded landscape.

The Toledo beds are derived from a mixture of calcareous limestone, sandstone, shale, mudstone and tuff. Local differences in soil quality and terrain result from variation in the composition of the underlying rocks. The most fertile soils (with the exception of available phosphorus) in the district are derived from the decomposition of limestone and tend to have high contents of expandable clay, dark topsoil colours, near neutral pH, and high levels of base saturation (King *et al.*, 1986). Agricultural potential is affected by the shrinking action of soils and development of wide and deep cracks during the dry months; while the swelling of clay particles hinders percolation of water through the soil to the point where the soil surface may be flooded during the rainy season (Nicolait *et al.*, 1984).

The drainage network in Toledo District is dense, comprised of seven perennial rivers which flow in a southeasterly direction from their headwaters in the Maya Mountains to the Caribbean Sea (Figure 5.2, page 62). During the wet season heavy rainfall causes flash flooding in the steep streams of the Mountains and inundation in the coastal plain. Seasonal precipitation can also result in erosion of soils where rapid surface runoff forms seasonal streams or sheet flows, except where karst (limestone) formations promote surface infiltration.

1.3 Vegetation

Six major ecological life zones for Belize are described by Nicolait *et al.* (1984); the Subtropical wet and the Tropical wet-transition to Subtropical zones applying to the research area. However, these zones could easily be described as subhumid tropical (lowland) and humid tropical (lowland) after the FAO classification (see section 1.1), since each are characterized by evergreen or semi-evergreen vegetation and, in the case

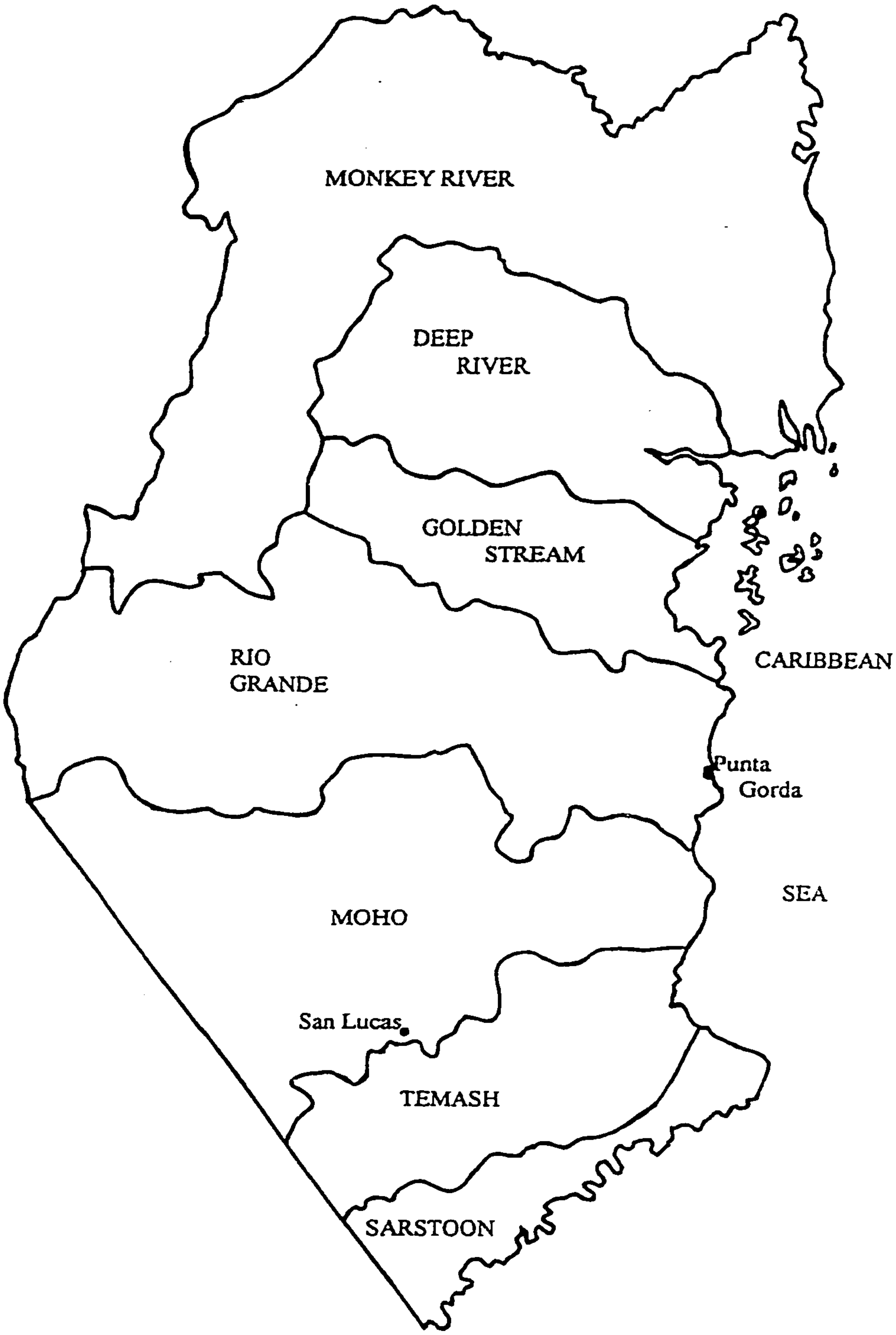


Figure 5.2 Drainage Network, Toledo District, Belize, Central America.

Source: Modified from King *et al.*, 1986.

of Toledo District: broad-leaved forest. Species characteristic to the study area include: *Vochysia hondurensis* (Yemeri), *Simarouba amara* (Negrito), *Calophyllum brasiliense* (Santa Maria), *Dalbergia stevensonii* (Rosewood), *Terminalia obovata* (Nargusta), *Manilkara zapota* (Sapodilla), *Cedrela odorata* (Cedar), *Swietenia macrophylla* (Mahogany), *Brosimum alicastrum* (Breadnut), *Pachira aquatica* (Provision Tree), *Cocos nucifera* (Coconut), *Orbigyna cohune* (Cohune Palm) and *Ceiba pendantra* (the "cotton tree").

Throughout Toledo District the broadleaf forest has the appearance of a stable plant community, although species composition was doubtless affected by the widespread use of limestone soils by the ancient Maya more than a millennium ago, the more recent and selective removal of logwood and mahogany and periodic devastation by hurricanes. The decline of the Maya civilization (approximately 850 AD), and associated large-scale abandonment of farms, permitted forest regeneration that has attained what some plant ecologists consider to be "climax" status. Further, removal of the remaining Chol Maya population by the Spanish in the 1600s further reduced the number of inhabitants; thereby, promoting forest regeneration. Between the 1600s and the early part of this century selective logging (mahogany and cedar for timber, rosewood for decorative timber, pine for timber and logwood and *Haematoxylum campechianum* for dye) along several rivers in Toledo probably had an impact on the structure and composition of the forest, although this has not been quantified. Finally, the impact of hurricane activity on the rainforest has been difficult to quantify because of the lack of adequate records documenting the occurrence and location of hurricane damage in all but the most recent decades.

It is interesting to note that although 74% of "forest land" in Belize is classified as closed broad-leaved forest, only 33% of this forest type is listed as Forest Reserves. Further, the "forest land" classification does not recognize the considerable impact of traditional slash and burn (milpa) and small farm agricultural activities; consequently, official statistics do not reflect the significant deforestation of western Cayo and southern Toledo Districts (CSO, 1994). According to analysis of aerial photographs by King *et al.* (1986) areas under cultivation in Toledo District increased by approximately 61% between 1970 and 1985, while forestry plantations virtually disappeared (see Table 2.1, page 14).

2.0 SELECTION OF STUDY SITE

The Toledo District of southern Belize was selected for the study for many reasons. First, I worked as an archaeologist in Belize and was familiar with the geography, demographics, political and socio-economic aspects of conducting a project in that area of Central America.

Second, I conducted a 14 day reconnaissance trip to Belize to identify a government ministry that would offer political support for my agroforestry study and to arrange meetings with appropriate government and community (i.e., village council) officials who would grant me permission to conduct my research. I met with the Chief Agriculture Officer at the Ministry of Agriculture and Fisheries (MOA) in Belmopan. He informed me that the MOA was interested in research and initiatives pertaining to sustainable land-use systems (i.e. agroforestry). I inquired about conducting my study in a Maya village in Cayo District (the western most district adjacent to Guatemala) near the area where I worked in previous years. Although Cayo District was not absolutely rejected; I was encouraged to consider Toledo District instead. MOA officials were concerned with the lack of research conducted in Toledo; the problem of subsistence and semi-subsistence producers, particularly those of Maya descent, petitioning the GOB for food supplements due to shortages before harvests from their main growing season were available; the amount of money the GOB was investing in promoting sustainable methods of production and the apparent lack of success that these efforts were having. The Chief Agriculture Officer encouraged me to attend a field day scheduled by MOA personnel in Toledo District over the following week as a means of meeting the staff and some local people.

I travelled to Punta Gorda, the capital of Toledo District, and introduced myself to personnel from both the MOA and the Department of Forestry. Naturally, the MOA personnel were informed of my visit before I arrived and were ready to transport me to the field day activities in Blue Creek village. A field day consists of agricultural seminars and hands-on demonstrations of techniques by MOA extension personnel. Many people, both female and male, from of the surrounding Kekchi and Mopan Maya villages, were attending this particular field day. During the first indoor session everyone, including myself and the extension personnel, were required to stand, introduce themselves and state why they were attending and what they hoped to learn. At my turn I took the opportunity to inform the participants about my proposed study and to ask anybody who was interested to approach me after the field day activities had concluded. Several people approached me for additional information, but one woman seemed more interested than the others and asked if I would visit her village - San Lucas. I agreed and arranged a lift from the district agronomist for the following day.

My visit to San Lucas was short, but I was able to meet with the *alcalde* (mayor) and the village chairman to discuss my proposed study. They agreed to let me to live in San Lucas and conduct my research provided that I did what I said that I was going to do and was not intending to profit from the study. I spent several hours meeting many of the villagers, rapidly appraising home gardens and photographing nearby milpas. During the drive (approximately 1.5 hours each way) I was also able to view other villages along the route and to develop a basic sense of what village life was like for the Maya in southern Toledo District. In addition, I was fortunate to be able to accompany the district agronomist on his village visits around the southern area of Toledo District for an additional four days. By visiting another 10 -12 villages I obtained a more comprehensive understanding of local production systems.

The Kekchi Maya village of San Lucas, located approximately 55 kilometers, by road, to the west of the district capital of Punta Gorda, was selected for the study not only because the villagers were willing to have a research project conducted in their village, but for several other reasons. From a purely practical standpoint, San Lucas was accessible by road; although wet season travel was periodically restricted by flooding of a main bridge found along the only road leading to the village.

Additionally, San Lucas was located further from Big Falls and Punta Gorda, the main commercial centres in the district, than many other Maya villages. This suggested that San Lucas villagers may have practiced more traditional means of production; influenced less by introduced technologies than villagers who live in closer proximity to, and who had year round access to, commercial centres. My previous observations of Maya home gardens in other parts of Belize, Mexico and Guatemala, in combination with five days of observing Maya villages around Toledo, led me to consider the possibility that San Lucas home gardens represented more traditional systems than those in villages closer to commercial centres where access to markets could influence the composition of home gardens. Although San Lucas had a small population in comparison with other nearby Kekchi Maya communities, it was representative in that it was relatively unaffected by market pressures and land pressures that were evident in Maya communities further to the north (Marcus, 1995; Berte, 1983) and, hence, closer to the main commercial centres.

Finally, I returned to Belmopan to meet with the Chief Agriculture Officer. We discussed MOA expectations and my research plan. I was granted permission to conduct my study and access to MOA reports and personnel as per availability. I left Belize with an official letter of permission in hand that was subsequently attached to several pending grant applications. The letter was also used, upon my return to Belize, to obtain an extended visa and a no fee permit for my vehicle.

3.0 SAMPLE SELECTION

The village of San Lucas is comprised of 19 HHs, with a total population of 116 individuals. All HHs have adjacent home gardens. Selection of participants was restricted by the small sample size and the willingness of individuals to participate in the study.

During my reconnaissance trip, I outlined my proposed research for members of the village council: the purpose of my study, what type of activities they could expect to see me engaged in, the extent to which I would expect their participation and that any member of the village could request to see my notes, maps or ask questions at any time.

They granted me permission to conduct the study, however, I repeated the process of explaining the research several months later when I arrived in the village to begin my investigations. After four or five days of discussions, and my responses to a wide variety of questions, providing assurances of confidentiality and ethical handling of information generated by the research, the council again agreed to my request provided that other villagers also agreed. I had passed the first stage!

Then, I visited both the male and female heads of each HH (usually the husband and wife), together, and repeated the study outline/explanation that I had presented to the village council. I answered villagers questions and asked them to think about participating in my study. I repeated this step over the course of three weeks with people approaching me to ask additional questions and discussing my proposed study among themselves. During this time I observed the daily routines of many people and, from a distance, began my initial drawings of home gardens. Finally, I requested a community meeting to ask who would be interested in participating in my study. No economic or other pressures were brought to bear on any villagers in an attempt to coerce their cooperation and those individuals and/or HHs declining to participate did not experience any negative repercussions or consequences as a result of their decision. Of the nineteen HHs forming the village of San Lucas, the female and male heads of fifteen HHs agreed to participate in the study, providing a small, fixed sample at near the saturation level.

Residents of San Lucas, including non-participant HHs, are comparatively homogeneous in their land-use practices, access to land and socio-economic framework. Therefore, variations in HH socio-economic status or accessibility to land and land-use practices were not considered viable factors to determine differences between HHs. Other factors needed to be identified for analysis.

The research was conducted between February and June of 1995 and November 1995 to June 1996. Primary data were collected from 15 HHs located in the Kekchi Maya village of San Lucas, Toledo District, Belize, Central America. Interview schedules were completed for each HH over a period of approximately ten months. Adult heads of HHs, usually married couples, participated in semi-structured (informal) interviews and focus group discussions, while participant observations provided baseline information and augmented the data recorded in interview schedules. Initially, couples were interviewed together and later men and women were interviewed separately. This was necessary to obtain perspectives that were not influenced by the presence of spouses. In particular, women had a tendency to allow their spouses to dominate discussions, they would say what they thought was expected of them or nothing at all.

Data collected was continuously cross-checked over the duration of the research period by repeating elements of the interview process; comparing responses between HHs; asking individuals the same questions, repeatedly, over a period of two or three months and by conducting focus group discussions. Repetitious questions were not asked using identical wording each time; but were incorporated into many informal conversations to confirm the validity of the data that was being collected.

4.0 METHODS

4.1 Diagnosis and Design (D&D) Approach

The Diagnosis and Design (D & D) approach, an adaptation of old or existing methodologies specific to the needs and conditions of agroforestry, was used as a framework for data collection. D & D is a holistic approach that emphasizes the role of trees within the farming system, that may be applied at variable scales (e.g., micro=household/family farm; meso=community, viliage or watershed and macro=region, country or ecozone) and places a greater emphasis on the iterative nature of the diagnostic and design process than do other, longer established methods, such as: Farming Systems Research/Extension (FSR/E) (Hildebrand, 1986; Shaner *et al.*, 1982) and the Land Evaluation Methodology (FAO, 1976). Further, "D & D is based on the premise that, by incorporating farmers into research and extension activities, subsequent recommendations and interventions will be more readily adopted" (Nair, 1993).

Table 5.1 The Diagnosis and Design (D &D) Methodology

D & D Stages	Questions to Answer	Investigative Mode
Prediagnostic	Define types of land-use and select site How does the system work? (organization, function)	Observing and comparing the different land-use systems Analyzing and describing the system
Diagnostic	How well does the system work? (identify problems, constraints, causes and mechanisms for intervention)	Diagnostic interviews and field observations
Design & evaluation	How to improve the system? (what is needed)	Iterative process and evaluation of alternatives
Planning	What can be done to develop and disseminate/share the improved system?	Research design, project planning
Implementation	How to integrate and adjust to new information?	Rediagnosis and redesign in response to new information

The D & D approach consist of five basic stages: prediagnostic, diagnostic, design & evaluation, planning and implementation (Nair, 1993). Each of the stages can be further divided into smaller steps as circumstances warrant (Nair, 1993), with the process being repeated over the course of the project so as to refine the original diagnosis and improve the technology design. The main features associated with the D & D approach are: flexibility (easily adaptable to fit the needs and resources of a wide variety of land-users), speed (allows for a "rapid appraisal") and repetition (is an open-ended learning process).

The study is primarily concerned with the prediagnostic and diagnostic stages of D & D, during which the researcher interacts with gardeners, other land-users and stakeholders either individually or in groups.

4.2 Intra-Household (IHH) or Gender Analysis Technique

In combination with the D & D stages mentioned above the Intra-Household (IHH) or gender analysis technique (Poats *et al.*, 1989) was integrated into the study. As part of FSR/E, IHH analysis "provides the means for relating HH structure and dynamics to technology development" (Poats *et al.*, 1989) by focusing on "three aspects underlying farmer decision making: the pattern of activities, access to and control of resources, and access to and control of benefits" (Feldstein *et al.*, 1989). Activity analysis, for example, requires the completion of an agricultural calendar that identifies tasks by gender, by asking who does what and when? Although seemingly simplistic, this type of analysis examines the patterns of activities and identifies potential labour constraints (i.e., seasonal bottlenecks) and competing activities. Resource analysis identifies production inputs and "asks who has access to and control of each, and the conditions governing that access" (Poats *et al.*, 1989). Finally, benefit analysis identifies who has what to gain from primary and residual farm outputs, asking "how products are consumed or exchanged and what characteristics are preferred by the product users" (Poats *et al.*, 1989). As a whole, the analysis allows researchers to predict the effect changes will have on species characteristics important to users or processors.

4.3 Interview Schedule

An interview schedule, rather than a questionnaire, was selected as the appropriate survey method for the study. Both questionnaires and interview schedules consist of a set of questions printed on prepared forms, ensuring that the same questions are asked of all participants. The difference between the two types of surveys exists in the method of application. While questionnaires are usually filled out by a range of literate respondents, interview schedules provide the researcher with a written format to guide interviews with literate or non-literate individuals and are filled out by the researcher or interviewer. During my study interview schedules were deemed the appropriate method to use since most of the participants were not literate and could not complete a questionnaire (see Appendix E for sample interview schedule).

Interview schedules were completed, over a period of five months at the beginning of the study, with information obtained during informal and formal interviews and through participant observations and focus groups. The schedules, one completed for each HH, provided baseline data on HH demographics, time allocated to specific activities and productive activities in San Lucas.

Methods used to complete interview schedules, as described above and following, correspond to the investigative modes utilized to answer questions posed during the first two stages of the Diagnostic & Design approach (D & D), prediagnostic and diagnostic (page 70), prevalent in agroforestry research. Further, the same methods were used, as part of the Intra-Household (IHH) or Gender Analysis Technique (page 71), to collect information about activity patterns and access to and control of resources and benefits. Data was presented in the form of harvest calendars and activity calendars, the latter of which were disaggregated by gender. All of the methods discussed in following sections not only corresponded to the D & D approach and the IHH technique for data collection, but they depended upon the application of an iterative process/cross-checking over the entire research period to ensure the most possible accuracy in data collecting and reporting.

Design of the final interview schedule took place at CATIE (Centro Agronomico Tropical de Investigacion y Ensenanza), Turrialba, Costa Rica. The interview schedule was based on similar documents utilized in CATIEs home garden research program. A significant duplication of questions was deliberately incorporated into my design to promote comparative analyses between my data and that collected by CATIE researchers. The schedule was also influenced by my previous knowledge of Maya home gardens, as well as information collected during a reconnaissance trip to the research site several months in advance of the actual study period. A fill-in-the-blank format, consisting of questions followed by a blank (________) that the interviewer fills in with the answer given by the respondent/participant, was most commonly utilized.

4.4 Participant Observation

Participant observation refers to living with people and sharing with them many aspects of their life, from subsistence activities to ritual occasions (Colfer, 1994 and 1981). There is no precise method to guide participant observation; the most important tools a researcher can use are curiosity, a willingness to learn from other people and an ability to adapt to a different way of life. Participant observation is a technique, used in D & D and IHH approaches to data collection and analysis (page 70 - 72), that we can all use as soon as we enter a community which is not our own and the things around us seem different and strange. We begin to notice what is different and what is similar to our own culture, including language, tools, foods, etc.. (Ladipo, 1994; Wollenberg, 1994; Johnson, 1975). This method is particularly good for gathering information concerning gender specific activities within each HH that are important for IHH analyses. It allows the researcher to find out who does what, how a certain activity is being performed (cultural practices), what levels of technology (varieties, tools, machinery) are being used, whether activities are done separately or jointly by men and women, and the constraints to performance (Paris, 1994).

I spent several months in San Lucas observing people as they went about their everyday activities, recording observations about local agriculture, plants and animals in home gardens, hunting, fishing, time allocated for specific activities and other relevant subjects. This permitted me to expand my knowledge of villagers' livelihood choices and strategies. My observations helped me to develop questions for semi-structured (informal) interviews and topics for focus group discussions.

In my opinion, observational methods are preferable to depending on participant reporting (record keeping) of the time they spend engaged in various activities (Suphanchaimat, 1994), for several reasons: individual record keeping requires literate participants; people's memories are unreliable (cross-checks are necessary); the activities that people are involved in automatically surface with the observational method, a minimal amount of time needs to be expended once the researcher is in the field and participant observation can broaden the researchers' network of ongoing community contacts (Colfer, 1994)

Observational data was initially used to collect ecological information that was related to species composition and interactions in home gardens, milpa gardens, milpas and forested areas. Additionally, observations were also used to generate D & D and IHH specific data, such as: home garden diagrams (physical structure); activity calendars indicating time allocated to specific tasks and disaggregation by gender and age (adult men, adult women, children, hired labourers); questions utilized during participant interviews and topics for focus group discussions and as a method of cross-checking verbal information collected throughout the research period. Finally, participant observation was a significant component of data collection and cross-checking over the research period.

4.5 Semi-Structured (Informal) Interviews

Semi-structured interviews provided much of the data that was recorded on interview schedules for each participating HH and was used to develop and complete activity and home garden harvest calendars. A set of topics and questions to be covered were prepared before each interview, based on information that I acquired from previous interactions in the community, including participant observation of everyday activities as well as informal conversations with villagers. An iterative approach was taken toward interviews, in which they were repeated with each participating gardener several times over the course of the project (Suphanchaimat, 1994), and in different locations depending upon where the villagers' daily routine would take them (i.e., home garden, milpa, hunting trip in the forest, market). Initial interviews reflected the D & D approach by concentrating on developing an overview of the whole system, identifying production activities and systems (including agroforestry systems) and specifically home gardens. During subsequent visits more details were obtained regarding village demographics and personal histories; identification of ecological, cultural and/or socio-economic and other forms of constraints to production; identification of the structure and function of species located in home gardens, milpas and forests and identification of gender roles as they relate to home garden production (Paris, 1994; Moser, 1989; Zeidenstein, 1979). As interviews progressed new topics and lines of inquiry naturally arose; however, I remained flexible and simply left some of my prepared questions for future discussions.

By incorporating information acquired from previous interactions in the community I was able to formulate - over time - more culturally appropriate questions, understand answers and improvise follow-up inquiries. These techniques allowed villagers to express themselves freely, rather than "choose" an answer to a dichotomous question (i.e., yes or no, true or false, agree or disagree), and turned out to be an important feature of doing research in San Lucas where the literacy rate is low and people are suspicious of "outsiders" who record everything in notebooks and on "official looking" forms. In fact, many people in San Lucas would become nervous, agitated and would not want to talk if I was writing during the conversation; therefore, interview records were discreetly written down after each conversation was finished.

These repeated, informal conversations were useful in building trust between myself and the study participants and permitted some measure of reliability that the data I collected was as accurate as possible because information could be continuously cross-checked between individuals, intra- and inter-HH, and/or developed as a topic for focus group discussions. In addition, I was able to freely communicate with women by turning the process into something familiar to them - a series of "social visits" - rather than something more formal and possibly more stressful.

Walking with the women and men through home gardens helps people feel at ease and it helps the researcher to see what questions to ask and it allows HH members to show off their knowledge. Ask what happens in other seasons and other places that I did not visit (Lightfoot *et al.*, 1994).

As part of the IHH approach, agricultural activity analysis was conducted using a twelve month calendar. The months were written across the top of the calendar and a set of activities, based on observations and information provided by participants during informal interviews, down the left side of the chart. Under each activity, the different sources of labour (family, hired) were classified by gender and age (male adult, female adult, children) (Paris, 1994) and both the FHH and MHH were asked: who usually does that? and how often? (daily, weekly, each morning). The point of understanding task specialization within the HH, and identifying the gender division of responsibility for labour management and disposal of all types of HH production, is crucial. Additional gender related questions were asked regarding access to resources such as land, capital, credit, training and HH and agricultural technologies. Questions on food consumption and preparation were asked since it was women's responsibility to secure and prepare food for the HH. Activities on the chart were mapped using symbols to represent who did the activity and when. Dry and wet seasons were also indicated on this calendar, showing the months when villagers may have run short of food (maize) and would seek assistance from the GOB or would have to spend more money on food items than normal (Buenavista and Flora, 1994; Feldstein and Poats, 1994).

Other information was collected, during informal interviews and focus group discussions, in association with the information on time use, including activity categories (weeding, irrigation, childcare), object of each action (weeding corn, collecting fuelwood, planting amaranth), and place for focus of action (home garden, milpa) (Wollenberg, 1994).

Again, as part of the IHH approach, informal interviews provided data concerning benefits analysis, who had access to the products of the HH as well as who controlled the decision making for each product. Both women and men described who used the product, how it was used, who decided how it would be used, and who controlled the money if it was sold (Buenavista and Flora, 1994). Participant gardeners were also asked about the amount of time they spent processing products, costs and returns involved in processing and purchasing and marketing practices (Paris, 1994).

Additional questions were asked about the access of women and men to income-generation activities (Paris, 1994). While farming was the major source of HH income in San Lucas, there were differences in men's and women's principal sources of income. For instance, working as hired agricultural labour in other villages, towns and fruit plantations were the major sources of off-farm income for men. Examples of women's income sources include selling produce from their home and milpa gardens, including vegetables, eggs and micro-livestock, handicrafts and forest extractives.

Difficulties with time allocation studies were that participants were doing more than one thing at a time (Colfer, 1994 and 1981). These joint activities (more than one activity by one person at the same time), sequential activities and group activities (more than one person) can present difficulties if not anticipated in advance (Wollenberg, 1994). A women's daily activity calendar (Table 6.3, page 95), developed as part of the IHH approach, for example, records the real time that women estimated that they contributed to specific tasks or activities.

4.6 Formal Interviews

A few formal interviews were conducted with select government officials representing the Ministry of Agriculture and Fisheries (MOA) and the Department of Forestry; two leaders of the Maya communities in Toledo District; three members of the village council in San Lucas and three women gardeners, two from San Lucas and one from Indian Creek Village. Answers to specific questions were sought regarding the history of Kekchi habitation in Toledo, current land-use issues, government policy and production.

4.7 Focus Groups

Focus group discussions were used to elicit participants perceptions of land-use constraints and opportunities, such as alternate production and management strategies;

but, occasionally deviated to other topics of interest to the group. Groups, comprised of no less than five and no more that fifteen participants, were divided by gender to promote the most effective interaction. This was done because my previous experience working among Maya people indicated that women seldom speak freely in front of men who, in their turn, tend to dominate group discussions where women are present. Segregation of female and male participants proved to be very effective (Flora, 1994; Kumar, 1987; Folch-Lyon, 1981) for isolating gender, and specifically women's perspectives on home gardening, other production systems, economic/cash crops, family size, flow of traditional knowledge, etc.. Size of focus groups depended upon the availability of participants. Factors such as the time of day, conflicts with other tasks and planned activities and trips away from the village all had to be taken into consideration when I planned focus group meetings.

4.8 Identification of Home Garden Species

Home garden species were identified, by scientific and/or commonly used local name, in four ways. First, I made visual identifications of some species to their common or scientific names. Second, villagers were asked to identify vegetative species by their Kekchi, Spanish or common names. Third, I compared physiological characteristics of each species to written descriptions and drawings or photographs from several published sources (Marsh *et al.*, 1995; Gentry, 1993; Mabberley, 1993; The Belize Forestry Department, 1946; Burdon, 1932). Fourth, when I could not identify species by using either of the first three methods I took samples of bark, leaves and/or fruit to the district agronomist and/or to Mr. C. Wright for identification.

If residents of San Lucas were able to provide a Kekchi, Spanish or common names for species I cross-referenced these with research conducted by Atran (1992), Holdridge (*et al.*, 1950) and other literary sources to make identifications. Further, at the time of the study, the district agronomist had worked among the villagers of Toledo District for approximately three years and was able to identify many different species. Mr. C. Wright had lived in Belize since co-authoring "Land In British Honduras" (Wright *et al.*, 1959), where he learned about the vegetation of the country.

All home garden species were identified using a combination of the methods indicated above and by cross-checking using the same methods. Many literary references were out of print, but were located in the National Archives of Belize, Belmopan.

4.9 Ethical Consideration

The privacy of study participants is preserved throughout this document by assigning a number ranging from G1 to G15 to each gardener and her associated garden. Numbers were issued at random and do not reflect any type of rank order. Individual or family names are not utilized in the presentation of data, nor in discussions.

5.0 CROSS-CULTURAL RESEARCH AND COMMUNICATION

Working with indigenous people who live in relatively isolated rural communities requires the researcher to have patience, tact and flexibility. The problems of cross-cultural communication and understanding are well illustrated by the extent to which I was required to modify my information collecting style. For example, the researcher may think that s/he is asking straight forward questions; however, the local participant may not "understand" the question due to the way it is stated. Although local participants or translators may "speak" the researchers principal language (English in this case), this does not mean that they have thorough knowledge of the intricacies of that language. There is a tremendous difference between knowing and being able to utilize basic forms of a language and understanding and being able to respond to a complex form of that spoken language. In addition, some English words may not be directly translatable into the participants language, and vice versa. This requires the researcher to modify her/his style in order to elicit the necessary information, thereby acknowledging the problems of language and interpretation.

During my research the problem of communication was further exacerbated by my inability to speak Kekchi, the local Maya dialect, and although most men and a few women in the village spoke English, the majority of women only spoke Kekchi. A local person was hired to translate in situations where verbal communication was difficult, however, even the translators work had to be cross-checked with English speaking villagers in order to ensure the highest possible accuracy of the data.

I believe that these are problems seldom encountered by agroforesters who focus on the more scientific, or production-based, aspects of the discipline.

6.0 ANALYSES

Data generated from participant observations, informal and formal interviews and focus group discussions, provided the basis/foundation for analysis and were continuously cross-checked throughout the study period using the same methods as indicated above.

All research methods contributed to the development of visual representations of the data, such as: activity calendars, histograms, pie charts and tables. Although much of the data presented in these ways was not analyzed using statistical methods, the information was, nevertheless, utilized in analyses. Statistical analyses of data was conducted, although it was limited by the small sample (15 gardens and 16 participants; the latter a result of two adult women inhabiting the same HH) size; which was close to saturation level since there were only a total of 19 HHs in San Lucas. The data collected was primarily categorical in nature, therefore, bivariate correlation was deemed to be the most appropriate method for analysis because it is used to describe the strength of relationships between variables. In other words, it measures associations between dependent and independent variables, rather than seeking evidence of a predictive relationship through the use of regression or other forms of analysis. Simple linear regression analysis was also utilized, in specific cases where both dependent and independent variables being tested consisted of categorical data, as a method of cross-checking the validity of correlation coefficients where significance was indicated. SPSS (Statistical Package for the Social Sciences) 8.0 and Excel 1997 were used to perform statistical tests.

Because the data were not derived from a controlled, experimental situation it was acknowledged that one or more variables, and/or outside forces not identified for testing, may have impacted the variables.

CHAPTER SIX

VI. RESULTS AND DISCUSSION

1.0 INTRODUCTION

The purpose of the study was to relate selected socio-economic and cultural factors, that may influence the decision making processes of gardeners, to the structure and function of their home gardens. An increased understanding of some of the forces that affect the diversity of home gardens is a tool that can be used by development professionals and extension personnel when collaborating with local Maya people in exploring sustainable alternatives and modifications to their traditional means of production. Alternatives and modifications are sought to mitigate the expanding problem of land pressure in Toledo District. A gender perspective was stressed throughout the course of the research.

Data collected in the village of San Lucas is primarily qualitative in nature. Emphasis was placed on HH demographics, home garden structure and function, land tenure, land-use, labour patterns and inputs/outputs. A structured interview schedule, informal and formal interviews, focus group discussions and researcher observations were utilized over the duration of the study to collect information. The interview schedule targeted the female head of each HH (FHH) because of her dominant role in home garden management. However, male heads of each HH (MHH) were asked to participate in the study by supplying estimates and information concerning land-use, production levels and inputs/outputs as they relate to the milpa system of agricultural production.

A holistic look at land-use and productions strategies utilized by the Kekchi Maya in San Lucas reveal a complex and dynamic structure of components, including home gardens, milpa gardens (plantations), milpa agriculture and forest resource/management zones. Combinations of these components are used to satisfy HH livelihood strategies. Components selected by HHs vary depending upon choices made by individuals and HH groups. Selections are based on a wide variety of factors including, but not limited to: amount of land allocated to each HH by village leaders, subsistence and cash requirements of HHs and constraints associated with inputs (i.e., availability of labour, tools, seed, cash). Many farmers in San Lucas choose to not to cultivate some types of milpas (i.e., ground foods and dry season milpas) in favour of obtaining wage labour, while others pool their resources to cultivate joint milpas. Joint cultivation is usually undertaken by family groups of brothers or fathers, sons and sons-in-law. Group milpa production allows individuals flexibility in sharing resources such as labour and capital inputs and permits some men to engage in wage labour away from the village.

The milpa system of agriculture is the principal form of production among all San Lucas HHs, requiring substantial amounts of land (Appendix A, page 180) and the bulk of male labour (Table 6.1, page 86) and capital inputs. Annually, each HH uses an average of 6.5 hectares (range: 0.4 - 9.6 hectares) of land for all types of milpa production, an average 7.6 hectares (range: 0 - 19.2 hectares) for forest resource/management zones (Appendix A, page 180) and an average of 0.36 hectares (range: 0.02 - 1 hectare) is devoted to home gardening (Figure 6.1, page 88), including HH structures. Yields from milpa production, specifically those related to maize, bean and ground food production, supply the majority of food required by each HH. Further, surpluses, usually of rice and beans, are sold for cash.

Table 6.1 Agricultural Activity Calendar. San Lucas, Belize. 1996.

	Months of the Year											
Climatic Conditions =	Wet/Dry		Dry		Wet				Less Wet - Drier			
Average Monthly ppt. (cm) =	17.38	10.73	7.76	7.99	21.1	62.41	78.11	64.57	52.03	32.34	22.34	19.34
Crop and Associated Activity												
MAIZE - WET SEASON	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Site selection	■											
Underbrush mature forest		Ͼ	Ͼ									
Fell large trees			■	■								
Burn dried vegetation				■□	■□							
Sow maize, squash & beans					Ͼ⊠							
Intercropping milpa					■□	■□						
Construct corn shed							■□					
Harvest: green corn							■□	■□				
Harvest: dry corn									❖	❖	❖	
'MATAHAMBRE' MAIZE - DRY SEASON	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Site selection and clearing										Ͼ		
Planting										Ͼ	Ͼ	
Herbicide application											■	■
Harvest	❖	❖	❖	❖								
BLACK BEANS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Planting	Ͼ											
Harvest			❖	❖								
UPLAND RICE	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Site clearing			Ͼ	Ͼ	Ͼ							
Planting					■□⊠							
Herbicide application						■□	■□					
Pesticide application								■				
Construct rice shed								■□				
Harvest and thresh								❖⊠	❖⊠	❖⊠		
Transport to market								■	■	■		
OTHER MILPA *	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Site clearing	■□	■□										
Planting			❖	❖	◆□●	••••	••••	••••	••••	••••	•••	◆□●
Harvest	❖	❖	❖	❖	❖	❖	❖	❖	❖	❖	❖	❖

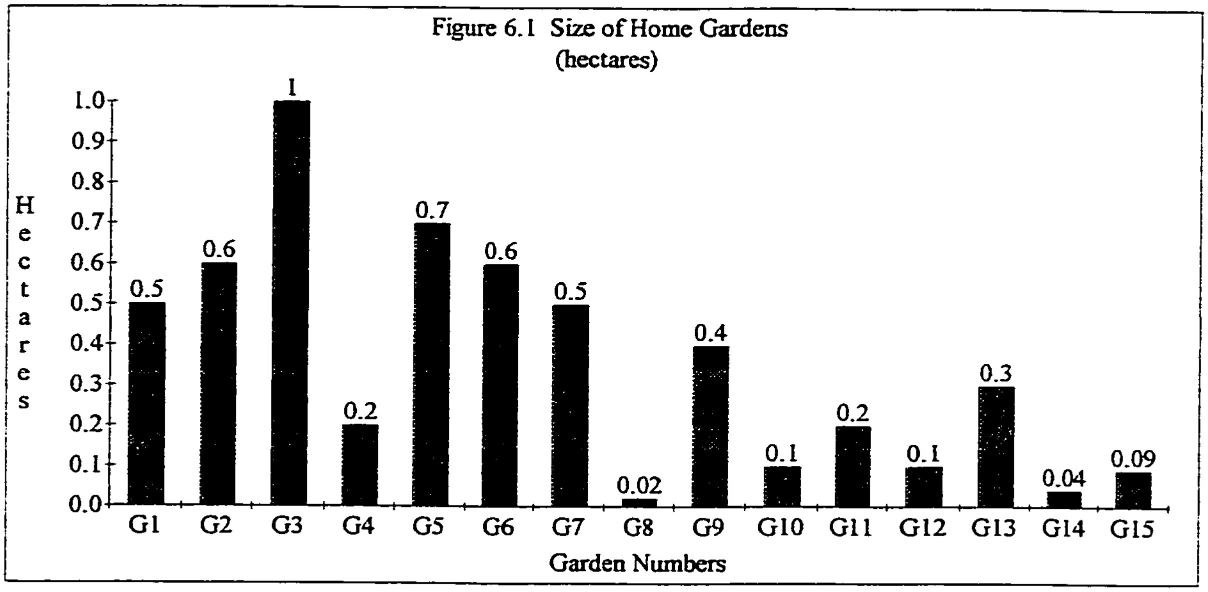
▤ Indicates the month of heaviest rainfall (July)
* Ground food or garden milpa
Ͼ communal labour party (males only)
■ male adult
◆ female adult
□ male child
● female child
❖ all HH members (male/female adults and children)
⊠ wage labourer (males only)
•••• indicates a continuous activity by female adults and male and female children

Two areas for which participants were unwilling to supply data were: (1) cash income levels per HH and, (2) medicinal plant knowledge and use, either in the home garden or in other areas of the village resource zone (i.e., forest, milpa, fallowed milpa, milpa garden, creekside). In the first instance, discussions regarding cash income were denied because most participants were not sure why I wanted to know and were suspicious that information about their income would be passed on to officials of the GOB. Any income data presented in this thesis was estimated by me and depends upon information received from sources other than the study participants in the village (i.e., prices obtained from the Belize Marketing Board (BMB), at local markets or by asking individuals how much they charge for specific items).

In the case of medicinal plants, villagers were wary of any foreigner asking questions because other Maya people had, in the past, shared information with outsiders and did not receive any monetary or other benefits derived from use of the knowledge. In essence, intellectual property rights, involving traditional knowledge of medicinal plants, were being exercised by the Kekchi in San Lucas. Throughout the duration of the study villagers would mention, but decline to identify, specific medicinal plants.

2.0 HOME GARDENS: STRUCTURE

Home gardens in San Lucas are not uniform in size or shape. This is demonstrated by schematic evidence (see Appendix D, page 183, for diagrams of selected home gardens) and measurements, the latter taken to determine the size of each garden. Ranging in size from approximately 0.02 to 1 hectare (Figure 6.1, below) the average size of home gardens in San Lucas is approximately 0.36 hectares.



Total Hectares for all San Lucas Home Gardens: 5.35 Average Size (ha): 0.36

The variable size and shape of home gardens in San Lucas is not surprising since gardens sites were acquired over time and under different circumstances. For example, Rico-Gray *et al.* (1990) point out that acquisition of land and further subdivision depends upon many factors. In San Lucas the shape and size of home gardens is determined by geographic (i.e., creek/stream flows or steeply sloped hillsides), political (i.e., boundaries of the community soccer field, churchyards, health post site and the location of the road) and social (i.e., boundaries of vegetation between HH compounds and pre-existing home garden sites) factors. San Lucas home gardens range from less than 0.5 to one hectare. This range is consistent with home gardens in other parts of the world (Fernandes and Nair, 1990; Budowski, 1985; Ninez, 1985; Allison, 1983). In addition, San Lucas home gardens also conform to other well accepted norms: they are located in cleared or semi-cleared areas adjacent to HHs or HH compounds and components are managed by family labour (Fernandes and Nair, 1986), primarily women and children.

Each group of HH structures is typically surrounded by two home garden zones. The first ranges between three and ten metres in width, is adjacent to and radiates from HH structures and is almost totally cleared of the naturally occurring, dense vegetation down to the grassy herbaceous layer. Fruit bearing trees, shrubs and herbaceous species may be planted or remain after clearing has taken place; while animal enclosures and fenced garden areas, the latter containing agricultural crops and some fruit trees, are added by HH members. Beyond this area extends a second zone which continues from the cleared area into the forest edge where useful trees, such as *Cocos nucifera* (coconut) and *Orbigyna cohune* (cohune) palms are retained during the process of clearing the undergrowth. Other useful trees such as *Brosimum alicastrum* (breadnut), *Mangifera indica* (mango), *Psidium guajava* (guava), *Musa [acuminata]* (banana) and *Theobroma cacao* (cacao) are interplanted amid reserved species. It should be noted that land clearing is not as thorough and management is not as intense in the forest edge zone compared to that which takes place closer to the HH; although both of these areas form home gardens.

The well cleared zone contiguous to HH structures exhibits several types of management, including fenced gardens, animal production enclosures, fruiting trees and herbaceous crops. Fenced areas are found within the boundary of each home garden and are mainly utilized during the dry season, between January and May, because local soils often become water-logged during the wet season often causing poor germination and an increase in diseases. Crude stick and pole fences are constructed to protect specific vegetable cash crops and young tree seedlings from potential destruction by free ranging domestic animals. *Lycopersicon esculentum* (tomato) and *Capsicum annuum* (green peppers) are the principal cash crops protected by fencing; however, young *Carica papaya* (papaya) and *Coffea arabica* (coffee) trees, *Brassica oleracea* (cabbage) and *Amaranthus* spp. (callaloo) are also prevalent. Fenced areas are abandoned during the wet season and are cleared or re-located for the next growing season. Fertilizers and manures are generally not applied to these management areas.

Vertical layers of crops and trees are evident throughout the home gardens. Short annuals, such as *Lycopersicon esculentum* (tomato), *Cucumis sativus* (cucumber), *Capsicum annuum* (sweet pepper) and *Capsicum frutescens* (chili pepper), in combination with perennials including *Eryngium foetidum* (cilantro), *Ananas comosus* (pineapple), *Cymbopogon citratus* (lemon grass), etc.. make up the lowest canopy; reaching heights of approximately 45 cm above the ground. The intermediate canopy is comprised of such crops as *Theobroma cacao* (cacao), coffee, papaya, banana, *Musa paradisiaca* (plantain), *Persea americana* (avocado), *Bixa orellana* (annatto) and *Citrus* spp. (lime). Within the forest edge management zone mango, breadnut, coconut, cohune palm, *Pachira aquatica* (provision trees), *Swietenia macrophylla* (mahogany), *Manilkara zapota* (sapodilla), among others, form the highest of the home garden canopies. Some of these trees reach 20 metres or higher with the *Ceiba pentandra* (ceiba) growing to above 30 metres.

3.0 HOME GARDENS: FUNCTION

The principal functions attached to species, and parts of species located in the home gardens of San Lucas were distinguished by gardeners over the duration of the study. The following broad categories were identified: edible/food, utilitarian, cash crop, ornamental, medicinal or shade (Table 6.2, below). I combined these categories were combined with the physical structure of species, as follows: woody perennial (i.e., trees, bamboo), shrub/vine and crop/herb. The function categories created, titled Grp1 through Grp18, each contain species that study participants identified by use/function (Table 6.3, page 92, Appendix G, page 200).

Table 6.2	Home Gardens: Function Categories and Definitions
FUNCTION CATEGORY	**DEFINITION**
Edible/Food	Plants and plant parts (i.e., fruit, leaves, bark, roots, sap, etc.) that primarily provide food for HH consumption. Also included in this category are plants and plant parts that are sold, traded or used to feed domestic animals.
Utilitarian	Plants from which parts (as above) may be used for fashioning HH utensils such as bowls and brooms, making lamp wicks and constructing seedbeds, fencing, animal enclosures and houses. The term 'utilitarian' is mine and was not used by study participants.
Cash Crop	Plants and plant parts (as above) that may be sold or traded at the inter- and intra-community level or further away at the district market in Punta Gorda.
Ornamental	Species that study participants identified as "pretty" and/or "make the place look nice."
Medicinal	Plants, and parts thereof, that are used to prepare oral or topical medicines and to administer or apply such medications.
Shade	Plants that provide shade for other plants growing within the boundaries of the home garden and/or for animals and people.

Three categories were not represented: ornamental woody perennials (Grp4), shrub/vine cash crops (Grp9) and shrubs/vines used for shade (Grp12). Although no data from San Lucas home gardens corresponded to these function categories, this should not preclude their potential viability either spatially (i.e., in another village, region or ecological zone) or temporally (over time). One category, crops/herbs used for shade (Grp18), was not deemed viable because ground level herb growth and crops in San Lucas home gardens were not being used to shade other plants, animals or people. In all honesty, participating gardeners giggled at the very idea of these types of plants shading anything!

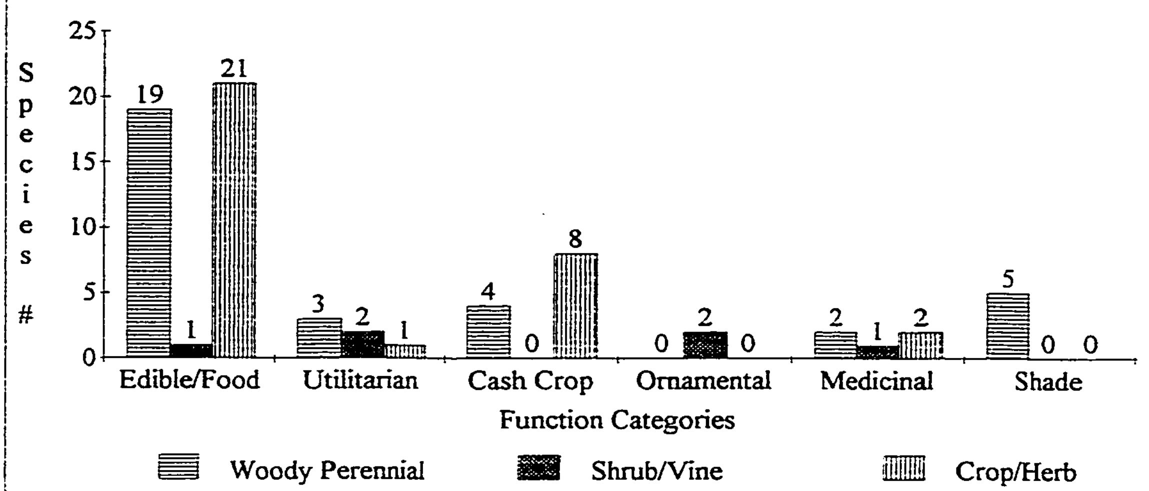
There were also several species that were counted in more than one category based on functional aspects identified by study participants. These are generally referred to as multi-purpose species. All broad categories; woody perennials, shrub/vine, cash crop and crop/herb; contained multi-purpose species (Table 6.3, below).

Table 6.3 Function Categories and Species Contained Therein

Grp1	**Grp4**	**Grp10**	**Grp14**
(Woody Perennial	(Woody Perennial	(Shrub / Vine	(Crop / Herb
—edible)	—ornamental)	—ornamental)	—utilitarian)
guava	**NIL**	cotton	fish poison plant
mango		hibiscus	
custard apple	**Grp5**		**Grp15**
craboo	(Woody Perennial	**Grp11**	(Crop / Herb
sweet lime	—medicinal)	(Shrub / Vine	—cash crop)
lime	avocado	—medicinal)	pineapple
orange	guava	cotton	watermelon
coffee			tomato
cacao	**Grp6**	**Grp12**	cabbage
avocado	(Woody Perennial	(Shrub / Vine	cucumber
banana	—shade)	—shade)	sweet pepper
plantain	mango	**NIL**	okra
annatto	malay apple		cilantro
papaya (small)	breadnut	**Grp13**	
papaya (large)	coconut	(Crop / Herb	**Grp16**
malay apple	cohune	—edible)	(Crop / Herb
coconut		sugarcane	—ornamental)
cohune	**Grp7**	pineapple	**NIL**
breadnut	(Shrub / Vine	watermelon	
	—edible)	sesame	**Grp17**
Grp2	chayote	gourd	(Crop / Herb
(Woody perennial		pumpkin/squash	—medicinal)
—utilitarian)	**Grp8**	chayote (cho cho)	lemon grass
cohune	(Shrub / Vine	tomato	snake plant
calabash	—utilitarian)	cabbage	
mahogany	Spanish towel	cucumber	**Grp18**
	cotton	sweet pepper	(Crop / Herb
Grp3		chili pepper	—shade)
(Woody perennial	**Grp9**	okra	**NIL**
—cash crop)	(Shrub / Vine	callaloo	
orange	—cash crop)	cassava	
cacao	**NIL**	cocoyam	
plantain		lemon grass	
papaya (large)		cilantro	
		benq	
		bullhoof	
		basil	

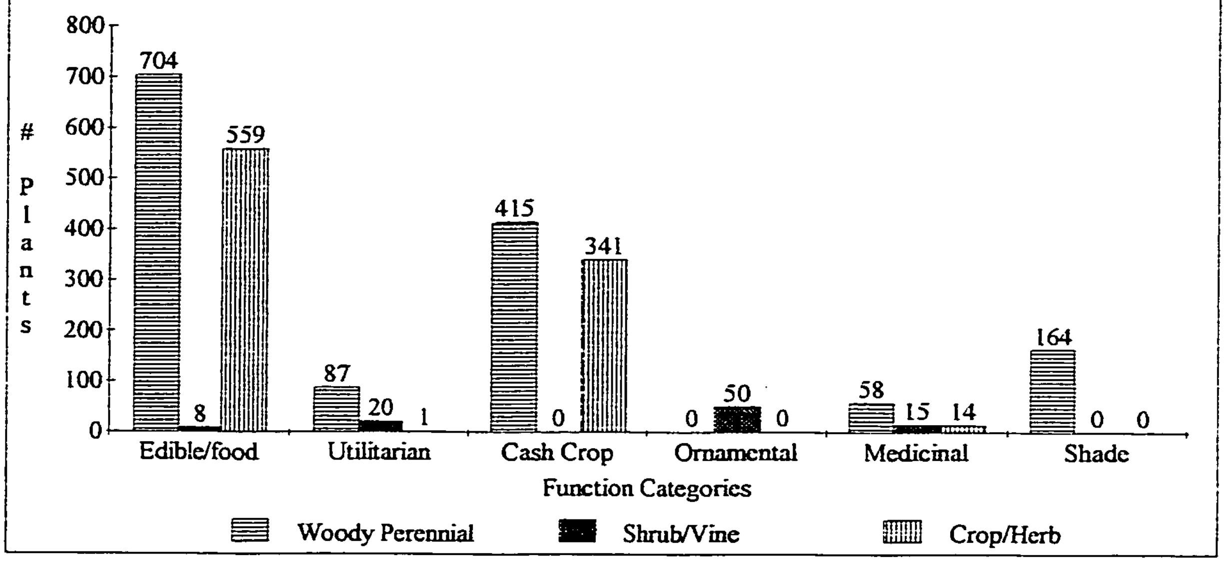
Of the 50 species found in San Lucas home gardens approximately 42% are classified as edible crops/herbs (Grp13), followed by edible woody perennials (Grp1) at approximately 38% (Appendix B, page 181). Combined, the species in the edible/food categories make up approximately 80% of all home garden species. Figure 6.2, below, provides compelling visual indication that edible/food species prevail in San Lucas home gardens.

Figure 6.2 Species Grouped by Function



The number of individual plants found in San Lucas home gardens supports the assumption that the majority of plants are utilized for food. Approximately 51% of all individual plants are classified as edible woody perennials (Grp1), followed by edible crops/herbs (Grp13) at approximately 40% (Appendix B, page 181). Combined, the count of individual plants in these edible/food categories make up approximately 91% of all plants found in San Lucas home gardens.

Figure 6.3 Plants Grouped by Function



Clearly, both the percentage of species and the percentage of individual plants found in San Lucas home gardens (80% and 91%, respectively) point to the primary function of these gardens as units of food production for HH consumption. This is in agreement with most research which also indicates food for family consumption as the main function of home gardens around the globe.

4.0 HOME GARDEN INPUTS

Additional data collected, included land-use data demonstrating the differences between crop and home garden production in terms of the amount of land utilized for each activity (Appendix A, page 180), estimated inputs/outputs and the level of investment (including labour) involved in various types of production (Table 6.1, page 86 and Table 6.4, page 96). For example, labour invested in the production of milpa crops was expected to exceed that utilized in home gardens because the villagers principal subsistence and cash crops are produced outside the home garden and because different combinations of labour forces are required over time. The extensive nature of milpa agriculture requires more labour during task specific seasonal bottlenecks where all adult family members, and in some cases wage labourers and children, participate in activities. In addition, maintenance of milpas continue throughout the production cycle. Conversely, women manage their home gardens almost continuously throughout the year, experiencing fewer and less intensive labour bottlenecks. Forest resources, while providing important products for the HH, both in terms of cash, food and other products, are mentioned, where necessary to demonstrate the amount of space and time required to harvest these resources. However, milpa and forest resources were not the focus of the study.

4.1 Inputs: Labour

Home gardens in San Lucas contain crops and trees at various stages of growth. Most agronomic practices are continuous throughout the year but generally peak during the dry season, between December/January and May. In any single day planting of new suckers (i.e., banana and plantain), pruning, weeding, seedbed construction, manuring, etc. is possible. During the wet season there is usually a lull in management activities due to heavy rainfall and waterlogged soils interfering with daily operations.

Women state that they work many more hours in home gardens than men. Most of their activities take place around daily HH chores, such as food preparation, washing, cleaning and childcare (Table 6.4, page 96). Each female head of HH (FHH) is principally responsible for making decisions regarding management, maintenance and production strategies in the home garden and HH. It is she who directs the gardening activities of other female HH members (i.e., her resident daughters and

Table 6.4	Women's Daily Activity Calendar. (estimated time given in hours per day)[1]				
Garden #	Cooking[2]	Childcare[3]	Gardening[4]	Laundry, Collect Water, Dishes[5]	Leisure Time[6]
G1	7	2	1.5	2	1
G1	7	7	0.5	2	1.5
G2	6	0	0.5	2	1
G3	10	6	2	4	1.5
G4	8	4	2	4	0.5
G5	9	5	1	4	0.5
G6	7	4	1	2	1.5
G7	9	7	0.5	5	0.5
G8	9	3	0.5	5	1
G9	9	5	1.5	5	1.5
G10	4	0	1	3	1.5
G11	10	3	0.5	5	0
G12	10	5	1	7	0
G13	6	4	0.5	3	1.5
G14	10	3	1	6	1
G15	9	6	0.5	6	1
Total	130	64	15.5	65	15.5
Avg.	8.13	4	0.97	4.06	0.97

1 Time was treated as though the activities were mutually exclusive, rather than overlapping (i.e., a woman could be cooking and watching her children at the same time). My survey did not acknowledge overlapping activities. Hourly estimates were obtained from participants during focus groups and informal interviews.

2 Cooking: includes preparation of food, feeding cooking fire, boiling drinking water, baking or cooking foods.

3 Preparation of food: shelling, soaking, boiling, rinsing and grinding maize; skinning, cleaning and butchering meat; kneading flour; etc..

4 Gardening: includes preparation of seedbeds, planting, tending, weeding, harvesting, drying, fencing, and animal husbandry (feeding, cleaning enclosures, application of medicine, etc..)

5 Laundry, Water Collection, Dishes: all these activities are conducted at the creek, away from HH dwellings.

6 Leisure: includes relaxing time, visiting friends, making handicrafts and fashioning HH tools (i.e., brooms).

daughters-in-law), deciding which species should be included in the garden, placement of most perennial vegetation, annual crop selection and sales of vegetable and micro-livestock produced in the home garden. The beginning of the dry season is the time when women construct and prepare seedbeds with tomato, cabbage and green pepper; transplant seedlings from seedbeds into fenced plots and add other species to the home garden as desired. The emerging growth requires daily watering and young children are kept busy carrying containers of water from the creek to the garden.

The male head of HH (MHH), his resident sons and sons-in-law, provide labour in the home garden in the form of initial clearing operations, pruning of trees, construction of animal enclosures and fences and periodic chopping of undesirable vegetative growth. In the early part of the dry season men use machetes to clear unwanted growth within the bounds of home gardens, leaving refuse in place to decompose or removing it to the outer boundary of the garden. From May to July men may prune some trees shortly after they cease to bear fruit. An extreme example is that of *Bixa orellana* (annatto) which is severely cut back at the beginning of the wet season to encourage healthy, thick growth.

In addition, the MHH participates in decision making regarding the inclusion of some higher input micro-livestock (i.e., pigs and chickens) and cash crop trees, such as orange.

4.2 Inputs: Tools

The level of technology demonstrated by villagers is rudimentary, electricity and fossil fuel powered machinery are not generally part of the home garden production system and draft animals are not utilized. Tools, such as machetes, axes, wooden digging/planting sticks, shovels and wheelbarrows are generally used for multiple tasks and are not utilized exclusively for home garden activities. Larger implements, such as a backpack-style chemical sprayer, are communal property and are shared among HHs. Some individuals are beginning to use power saws for milpa clearing but not in the home garden, with the exception, occasionally, of clearing for garden/HH establishment.

4.3 Inputs: Chemical

Purchased fertilizers are seldom utilized in home garden plots. Investment in these is usually reserved for cash crops such as rice. HH trash and leaf litter, minimal amounts of animal dung from free ranging chickens, pigs, turkeys and ducks and human excrement add to soil fertility in home gardens. Nutrients contained in human excrement are generally deposited only along the outer edge of home gardens rather than throughout the plot where nutrients would be more available to crops and trees grown adjacent to HH structures. Only a small amount of HH trash is produced and deposited into the home garden. Free ranging domestic animals, including horses and especially dogs, forage on the trash, eventually re-depositing it not only in the home garden but throughout the animals foraging area (village, milpa, jungle). A potential source of nutrients for enhancing soil fertility, the manure of penned animals, is occasionally collected and distributed in the home garden.

Pesticides and herbicides are rarely applied to home gardens for a variety of reasons, including: the lack of access to products, the expense and because some gardeners are suspicious that pesticides will kill their economic plants. I have included the latter because a few gardeners told me the following story to explain their suspicions. It seems there was an incident in which one villager, the Ministry of Agriculture (MOA) representative in the community, volunteered to spray pesticide on vegetables in all home gardens. Subsequent to the application of the spray, most of the vegetable crops in San Lucas home gardens failed, with the exception of the vegetables grown by the wife of the MOA representative. This generated the widespread belief among home gardeners that the chemical had killed their vegetable crops. Naturally, there is no tangible evidence that the pesticide was the cause of the crop failures.

4.4 Inputs: Seed, Seedlings and Cuttings

Seeds, seedlings and cuttings are obtained for home garden use in a variety of ways, including: as gifts, in trade or exchanged among members of a gardeners extended family (either intra- or inter-village), harvested from mature plants that have gone to seed, transplanted from the forest or purchased.

Seeds (specifically non-endemic and/or genetically engineered species) are occasionally purchased by home gardeners at local farmers depots or are supplied by MOA representatives as part of existing and/or previous programs. Seeds, both purchased and collected, are germinated in raised seedbeds constructed in a shaded portion of the home garden. This is an attempt to protect young shoots from weather, insect pests, various diseases and free-ranging domestic animals.

Another type of seedbed that women develop in their home gardens is located inside the main and/or kitchen dwelling. Soil is loosely spread on the beaten earth floor, under the kitchen work table, and cuttings from garden milpa species (i.e., ginger, chayote, sweet potato, etc.) are placed in the soil. The cuttings are protected from free-ranging animals, weather, and water from food preparation spills through the boards on the table onto the cuttings. Once cuttings sprout they are transferred into the woman's home or milpa garden.

4.5 Inputs: Farm Credit

At the time of the study neither home gardens nor milpa production activities were eligible to receive farm credit from the Belize Bank, the Reconstruction and Development Bank, government partnership initiatives with international organizations or private interests. This is primarily due to strict conditions requiring collateral to guarantee farm loans. In general, the lack of collateral is directly related to the communal nature of land tenure in the Maya villages of southern Belize. Because the land is not individually owned it cannot be utilized as security to obtain loans. For this reason many farmers are pushing to abolish communal holdings, at least in part, so that they will have secure tenure to a piece of land and are able to apply for loans to develop it as they would like.

What are the implications for home garden management and composition were farm credit to be readily available? Would women, as principally subsistence producers, be eligible to receive credit, or would men be the only HH members to obtain credit? Given that credit became available, it is likely that subsistence and wild plants would be replaced by cash crops in the home garden in order to ensure repayment of loans. In general men are associated with production of cash crops; therefore, the potential exists that women may lose control of home garden composition and management activities.

5.0 HOME GARDEN PRODUCTIVITY, INCOME GENERATED AND LOSSES

Harvest of species from San Lucas home gardens is roughly continuous throughout the year (Table 6.5, below). Home garden yield data was collected from gardeners, MHH and village children through informal interviews/conversations and participant observation. Gardeners and MHH were asked to estimate, to the best of their recollection, previous harvests from home garden species. Children proved to be a good source of information since they regularly foraged for harvestable items in their HH home gardens and the gardens of close relatives, such as grandparents or aunts and uncles.

The following table consists of home garden yield data obtained from a combination of gardener estimates, as above, my observations of gardeners' and childrens' foraging activities and information related to me by children in San Lucas. Several points of interest should be kept in mind when viewing yield data. Firstly, relying on villagers to accurately remember amounts from previous harvest periods is risky and any estimates given are just that, estimates. Secondly, immature woody perennial species, although currently managed by gardeners, do not figure in the table below since they were not bearing harvestable products at the time of the study. Thirdly, since home gardens are dynamic systems it is important to acknowledge that current management strategies reflect gardeners' future plans, which take into account the potential productivity of today's immature species. Finally, although I do concede that the following data is incomplete, I believe it is important to include such information so that readers may gain some insight into the amount of harvestables that are generally available from mature species San Lucas home gardens.

Table 6.5 Home Garden Harvest Calendar - San Lucas, Belize. 1995-1996.

Crop /	Climatic Conditions =	Wet/ Dry		Dry		Wet				Less Wet/ Drier			
		Months of the Year											
Scientific Name	English Name	J	F	M	A	M	J	J	A	S	O	N	D
Psidium guajava	guava	X	X	X	X								
Mangifera indica	mango	X			X	X	X	X			X	X	X
Annona squamosa	custard apple	X	X										
Byrsonima crassifolia	craboo / nance	X				X	X	X				X	X
Citrus aurantifolia	sweet lime	X					X	X	X	X	X	X	X
Citrus spp.(limon)	lime				X	X	X	X	X	X	X	X	X
Citrus sinensis	orange	X			X	X	X	X		X	X	X	X
Coffea arabica	coffee				X	X	X						
Theobroma cacao	cacao		X	X	X	X	X	X					
Persea americana	avocado							X	X	X	X	X	X
Musa (acuminata)	banana	●	●	●	●	●	●	●	●	●	●	●	●
Musa paradisiaca	plantain	●	●	●	●	●	●	●	●	●	●	●	●
Bixa orellana	annatto			X	X	X							
Carica papaya	papaya - small	X	X	X	X	X	X				X	X	X
Carica papaya	papaya - large		X	X	X	X	X						
Spondias purpurea	golden plum/hogplum					X	X	X	X				
Syzygium malacccense (?)	malay apple				X	X	X	X	X				
unidentified	(?) che chay												
Cocos nucifera	coconut palm	●	●	●	●	●	●	●	●	●	●	●	●
Orbigyna cohune	cohune palm	●	●	●	●	●	●	●	●	●	●	●	●
Brosimum alicastrum	breadnut					X	X	X	X				
Crescentia cujete	calabash	X	X								X	X	X
Swietenia macrophylla	mahogany	●	●	●	●	●	●	●	●	●	●	●	●
Metopium brownei	poison wood	●	●	●	●	●	●	●	●	●	●	●	●
Croton spp.	croton	●	●	●	●	●	●	●	●	●	●	●	●
Hibiscus spp.	hibiscus	X	X	X	X	X							
Sanseviertia trifasclata	snake plant	●	●	●	●	●	●	●	●	●	●	●	●
Gossypium hirsutum	cotton	X	X	X	X	X	X						
Luffa cylindrica	spanish towel	X	X	X	X	X	X						X

● Indicates continuous or almost continuous harvests

X Indicates harvest periods during specific times of the year

Table 6.5 Home Garden Harvest Calendar - San Lucas, Belize. 1995-1996.

		Months of the Year											
Crop /	Climatic Conditions =	**Wet/ Dry**		**Dry**		**Wet**				**Less Wet/ Drier**			
Scientific Name	English Name	J	F	M	A	M	J	J	A	S	O	N	D
Saccaharum officinarum	sugarcane				X	X	X	X	X	X	X	X	X
Ananas comosus	pineapple				X	X	X						
Citrullus lanatus	watermelon			X	X	X	X						
Sesamum indicum	sesame/wangla		X	X	X	X							
Lagenaria siceraria	gourd			X	X	X	X	X					
Cucurbita moschata	pumpkin/squash			X	X	X	X	X	X	X			
Sechium edule	chayote (cho cho)	●	●	●	●	●	●	●	●	●	●	●	●
Lycopersicon esculentum	tomato		X	X	X	X	X						
Brassica oleracea	cabbage	X	X	X	X	X							X
Cucumis sativus	cucumber	X	X	X	X	X							X
Capsicum annuum	sweet pepper	X	X	X	X	X							X
Capsicum frutescens	chili pepper	X	X	X	X	X	X					X	X
Hibiscus esculentus	okra	X	X	X	X	X	X					X	X
Amaranthus (hybridus)	callaloo	●	●	●	●	●	●	●	●	●	●	●	●
Manihot esculenta	cassava/manioc	●	●	●	●	●	●	●	●	●	●	●	●
Colocasia esculenta	cocoyam	●	●	●	●	●	●	●	●	●	●	●	●
Dioscorea trifida	yampi/taro/dasheen	●	●	●	●	●	●	●	●	●	●	●	●
Ipomoea batatas	sweet potato	●	●	●	●	●	●	●	●	●	●	●	●
Cymbopogon citratus	lemon grass	●	●	●	●	●	●	●	●	●	●	●	●
Eryngium foetidum	culantro	●	●	●	●	●	●	●	●	●	●	●	●
unidentified	(herb) ?	●	●	●	●	●	●	●	●	●	●	●	●
Piper umbellatum	bullhoof	●	●	●	●	●	●	●	●	●	●	●	●
Zingiber officinale	ginger	●	●	●	●	●	●	●	●	●	●	●	●
Ocimum basilicum	basil	●	●	●	●	●	●	●	●	●	●	●	●
Lonchocarpus castilloi	fish poison plant				X	X	X	X	X	X			

● Indicates continuous or almost continuous harvests

X Indicates harvest periods during specific times of the year

Table 6.6	Home Garden Yield Data. San Lucas, Belize.			
Scientific Name	**Common Name**	**Product Use/Type**	**Amount Harvested Per Individual**	**Who Harvests**
Psidium guajava	Guava	E: fruit	25 +	Children, gardener
Psidium guajava	Guava	M: leaf	as necessary	Gardener
Mangifera indica	Mango	E: fruit	100 +	Children, gardener, MHH
Annona squamosa	Custard Apple	E: fruit	35-80 +	Children, gardener
Brysonima crassifolia	Craboo	E: fruit	30 - 100	Children, gardener, MHH
Citrus aurantifolia	Sweet Lime	E: fruit	60 +	Gardener, children
Citrus spp. (limon)	Lime	E: fruit	40 +	Gardener
Citrus sinensis	Orange	E: fruit; CC	50 - 100 +	MHH, gardener, children
Coffea arabica	Coffee	E: seed	25 +	Gardener
Theobroma cacao	Cacao	E: fruit	10 - 20	Gardener, MHH, children
Persea americana	Avocado	E: fruit	30 - 100 +	Gardener, MHH, children
Musa (acuminata)	Banana	E: fruit	1 bunch (40-60)	Gardener, children, MHH
Musa paradisiaca	Plantain	E: fruit	1 bunch (30 +)	MHH, gardener
Bixa orellana	Annatto	E: fruit (seed)	50 - 100 +	Gardener, children
Cocos nucifera	Coconut	E: fruit	15 +	Children, MHH
Orbigyna cohune	Cohune	E: fruit	2 bunches (80 +)	Children
Brosimum alicastrum	Breadnut	E: fruit	30 - 80 +	Children, MHH, gardener
Gossypium hirsutum	Cotton	M: bols	20 - 50 +	Gardener, children
Saccaharum officinarum	Sugarcane	E:stalk/sap	1 stalk/plant	Gardener, MHH
Ananas comosus	Pineapple	E: fruit	1 fruit/plant	Gardener
Sechium edule	Chayote	E: fruit	8 - 12 +	Gardener
Lycopersicon esculentum	Tomato	E: fruit	8 - 15 +	Gardener
Capsicum annuum	Sweet Pepper	E: fruit	3 - 8 +	Gardener
Capsicum frutescens	Chili Pepper	E: fruit	10 - 25 +	Gardener, children
Amaranthus (hybridus?)	Callaloo	E: leaves	3 - 12 handfuls	Gardener
Cymbopogon citratus	Lemon Grass	E: leaves	continuous handfuls	Gardener
Eryngium foetidum	Cilantro	E: leaves	continuous handfuls	Gardener, children
Piper umbellatum	Bullhoof	E: leaves	occasional leaf picked	Gardener

E = edible   M = medicinal   CC = cash crop

Note: all data is derived from gardener, MHH and childrens estimates of previous yields in combination with participant observations of amounts harvested and use of harvested products, as well as focus group discussions.

Cash crop and micro-livestock outputs were easier to determine. Estimates of cash crop totals have been obtained from gardeners according to sales by pound and by number of items, bunches, handfuls, buckets, etc. In the case of micro-livestock (i.e., chicken, turkey, duck, pig), estimates of price per pound were collected for chicken but were sketchy for other animals. Since most other forms of micro-livestock are consumed by family members, given to relatives, traded for other products, used to feed visitors, slaughtered for holidays and feast days or used to fulfill obligations, such as feeding members of a men's agricultural work group, price per pound estimates were not readily available.

Table 6.7 Home Garden Production: Portion, Price and Market

Product	Portion Size	Price per Portion	Market
tomato	pound	$1.00	intra- inter-village
callaloo	bunch	$0.50	inter-village
green pepper	pound	$1.25	intra- inter-village
chili pepper	pound	$0.50	intra- inter-village
okra	handful	$0.50	intra- inter-village
cacao	pod	$0.50	intra- inter-village
chicken	pound	$1.50	intra-village
chicken eggs	each egg	$0.25	intra-village

All prices are given in Belize dollars. $1.00 Belize = $0.50 US

Losses associated with home garden production often occur as a result of insect, bird and animal predation, a variety of diseases and the growth of vines in the canopy of some fruit trees. For example, leaf cutter ants are particularly fond of citrus foliage and are capable of killing seedlings and young trees within a few days. During the wet season vines grow rapidly, often engulfing the canopy of mature fruit-bearing trees such as mango, orange and breadnut. Gardeners stated that they see reductions in fruit production, and health of plants, as a result of vines covering the canopy of fruiting trees and insects damaging immature individuals.

No data was collected regarding the percentage of loss incurred in San Lucas home gardens. Although birds, animals and insects did inflict damage on plants in San Lucas home gardens and harvestables, these were not measured since the focus of the research was not specific to this topic.

6.0 VARIABLES

Dependent variables refer to the physical structure of home gardens in San Lucas (i.e., number of species and individual plants). Independent variables comprise the following categories: gardener/household (HH) data (i.e., demographics), residence history of gardeners, traditional environmental knowledge (TEK) and function of home garden species (see Table 6.8, below).

Table 6.8	Title and Description of Variables Utilized in Analyses
VARIABLES	DESCRIPTION
	DEPENDENT VARIABLES
Species	Total number of vegetative species found in home gardens
Plants	Total number of individual plants present in home gardens
	INDEPENDENT VARIABLES
	GARDENER/HOUSEHOLD DATA
Age	Age of gardener (1996)
Education	Level of education possessed by each gardener
Totalkid	Number of gardeners children currently living in the HH
Girls	Number of girls, +8 yrs. of age, currently living in HH; excludes FHH
Kids1	Number of children, 0-7 yrs. of age, currently living in the HH
Kids2	Number of children, +8 yrs. of age, currently living in the HH
	RESIDENCE HISTORY OF GARDENERS
Origin	Country of origin/birth of gardener: Belize or Guatemala
Residence	Length of gardeners residence (in months) in San Lucas
	TRADITIONAL ENVIRONMENT KNOWLEDGE (TEK)
TEK 1	Active relationship between gardener and her extended family
TEK 2	Gardener obtained comprehensive environmental knowledge from older female family member (mother, grandmother, aunt, etc.)
TEK 3	Gardener obtained home garden management knowledge from older female family member (specific to home gardens)
TEK 4	Gardener obtained comprehensive environmental knowledge from other female family member or in-laws
TEK 5	Gardener obtained comprehensive environmental knowledge from a male family member (father, uncle, grandfather, brother)
	HOME GARDEN SPECIES GROUPED BY FUNCTION
	(list of species corresponding to group numbers to follow)
Grp1	Trees (woody perennials): edible/food (leaves, fruit, bark, etc.)
Grp2	Trees (woody perennials): utilitarian (leaves for roofing, lumber, etc.)
Grp3	Trees (woody perennials): cash crop (fruit, leaves, bark, lumber, etc.)
Grp4	Trees (woody perennials): ornamental
Grp5	Trees (woody perennials): medicinal (leaves, fruit, bark, roots, etc.)
Grp6	Trees (woody perennials): shade (for people, animals, vegetation)
Grp7	Shrub/vine: edible/food (leaves, fruit, bark, etc.)
Grp8	Shrub/vine: utilitarian (brooms, wrapping for food, fencing, etc.)
Grp9	Shrub/vine: cash crop (fruit, leaves, bark, roots, etc.)
Grp10	Shrub/vine: ornamental
Grp11	Shrub/vine: medicinal (leaves, fruit, bark, roots, etc.)
Grp12	Shrub/vine: shade (for people, animals, other vegetation)
Grp13	Crop/herb: edible/food (leaves, fruit, bark, root, etc.)
Grp14	Crop/herb: utilitarian
Grp15	Crop/herb: cash crop (fruit, leaves, bark, roots, etc.)
Grp16	Crop/herb: ornamental
Grp17	Crop/herb: medicinal (leaves, fruit, bark, roots, etc.)
Grp18	Crop/herb: shade

6.1 Dependent Variables: Species and Plants

6.1.1 Species

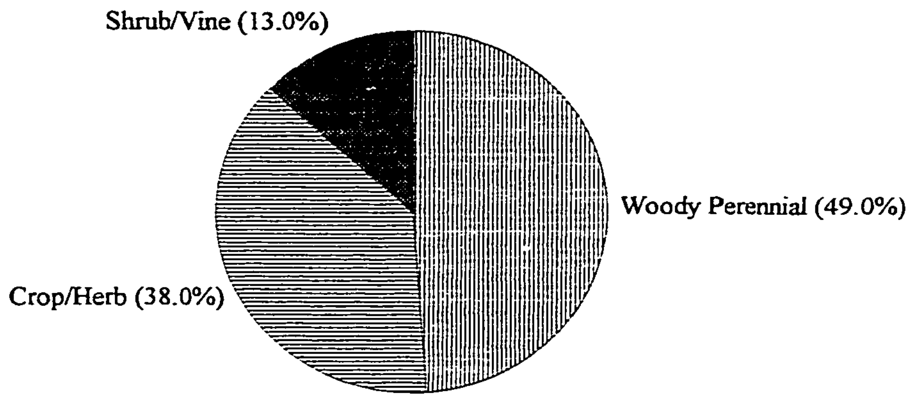
This dependent variable refers to the composition of species found in the 15 home gardens sampled. A total of 50 economic species (trees, shrubs/vines and crops/herbs) were variously represented in each of the home gardens (Appendix B, page 181). Economic species are utilized by members of the HH for a variety of purposes, such as shade, food, medicine and as ornamentals. Species of economic importance include those that pre-date the establishment of current home gardens and that are spared during clearing of the garden areas and those that have been planted by the current occupants. Non-economic vegetative species (those species not mentioned by gardeners during interviews and those that gardeners were not observed to be using) were not counted.

A complete list of species and their counts by garden number (designated G1 to G15) appear in Appendix B, page 181. Counts indicated with a lower case "x" are indicative of those species that grow in clumps (i.e., *Cymbopogon citratus* [lemon grass]) or patches (i.e., *Sanseviertia trifasclata* [snake plant] and *Eryngium foetidum* [cilantro]). For purposes of statistical analysis those species growing in clumps or patches are counted as one (1) individual due to the impossibility of being able to count all plants present in such arrangements.

Species composition did not vary widely between home gardens in San Lucas. In other words, there was a large amount of species overlap between gardens, with each HH having a common selection of fruit trees, useful shrubs, crops and ornamentals. A complete list of species, including scientific name, Kekchi name and common name can be found in Appendix B, page 181.

Distribution of species, based on inclusion in three broad categories: woody perennials, shrubs/vines and crops/herbs, indicates that the majority of species in San Lucas home garden were woody perennials (approximately 49%), followed by crops/herbs (38%) and shrubs/vines (13%) (Figure 6.4, below).

Figure 6.4 Percentage of Species in Home Gardens



6.1.2 Plants

The dependent variable, Plants, refers to the number of individual plants, of economic importance, located in each home garden. Seedlings and mature individuals were counted. The dynamic nature of home gardens is such that immature individuals are part of the overall regeneration plan for the garden and are cultivated with a specific outcome in mind and were, therefore, included.

The number of individual plants in each garden (numbered G1 to G15), by species, can be found in Appendix B, page 181, as well as overall totals for all gardens tested. The number of plants in home gardens, divided into three broad categories: woody perennials, shrubs/vines and crops/herbs, indicate that a majority of the plants in San Lucas home gardens were crops/herbs (approximately 50%), followed by woody perennials (40%) and shrubs/vines (10%) (Figure 6.5, below).

Figure 6.5 Percentage of Individual Plants in Home Gardens

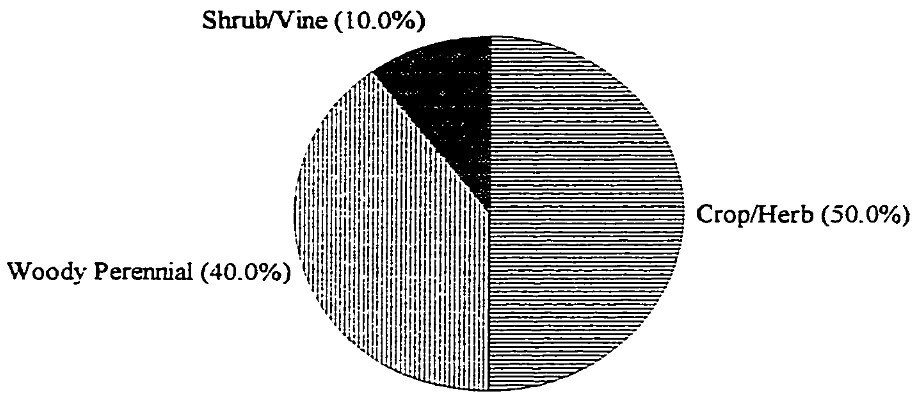


Table 6.9 (page 111, following) shows the results, significant and not significant, of correlation analysis between dependent and independent variables tested. Some variables, for which there were no observations, were omitted from analyses. For example, the Grp18 category was not valid and Grp4 (ornamental woody perennials), Grp9 (shrub/vine cash crops), Grp12 (shrubs/vines used for shade) and Grp16 (ornamental crops/herbs) were not represented because no observations were made during collection of data.

Table 6.9 Correlation Coefficients: Dependent x Independent Variables

DEPENDENT VARIABLES	INDEPENDENT VARIABLES				
	Age	Origin	Education	TEK5	
Species	.042	.413	.331	.358	
Plants	.035	.451	**.635****	.335	
	Totalkid	Girls	Kids1	Kids2	Reside
Species	.067	.066	.069	.054	**.593***
Plants	.238	.331	.128	.260	.317
	Grp1	Grp2	Grp3	Grp5	Grp6
Species	**.628****	**.568***	**.540***	.314	**.748****
Plants	**.957****	**.588***	**.916****	**.559***	**.894****
	Grp7	Grp8	Grp10	Grp11	Grp13
Species	.054	.110	.357	-.222	**.863****
Plants	-.142	.076	**.742****	-.085	**.716****
	Grp14	Grp15	Grp17		
Species	-.226	**.854****	.419		
Plants	-.177	**.840****	**.607***		

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.
Significant correlations appear in bold.

Table 6.10 Correlation Coefficients: Functional Groups x Other Independent Variables

DEPENDENT VARIABLES	INDEPENDENT VARIABLES							
	Age	Origin	Education	Totalkid	Girls	Kids1	Kids2	TEK5
Grp1	.056	.448	**.691****	.222	.391	.075	.267	.273
Grp2	.314	.496	**.533***	.253	.186	.152	.267	**.513***
Grp3	.004	.403	**.701***	.226	.398	.096	.260	.218
Grp5	**.501***	.403	.226	.041	.039	-.178	.159	.098
Grp6	.212	**.566***	**.628***	.180	.266	.052	.222	.461
Grp7	-.353	-.249	-.140	-.068	-.258	-.223	-.221	-.477
Grp8	-.277	-.051	.048	-.249	-.184	-.111	-.283	-.098
Grp10	.071	.305	**.553***	.078	.199	.014	.101	.124
Grp11	**.687****	.113	-.106	-.095	-.167	-.282	.028	-.114
Grp13	-.044	.274	.279	.234	.104	.238	.191	.349
Grp14	-.125	-.174	-.098	.112	.145	.107	.095	.200
Grp15	-.109	.349	.419	.240	.137	.297	.166	.220
Grp17	.213	.163	**.543***	**.506***	**.588***	.139	**.627****	.311

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.
Significant correlations appear in bold.

In San Lucas home gardens the number of species found in home gardens seem to "top out" in the upper 20s, while plant counts are unfettered. Reasons for this vary between HHs, including, but not limited to: the availability of different types of plants, gardeners may simply be used to a specific plant complex around their homes, free-ranging domestic animals may destroy species in shrub and herbaceous layers, cash crops may not be widely cultivated because it is difficult to secure transportation to the market and many common food plants are still cultivated in milpa gardens and along the border of maize milpas.

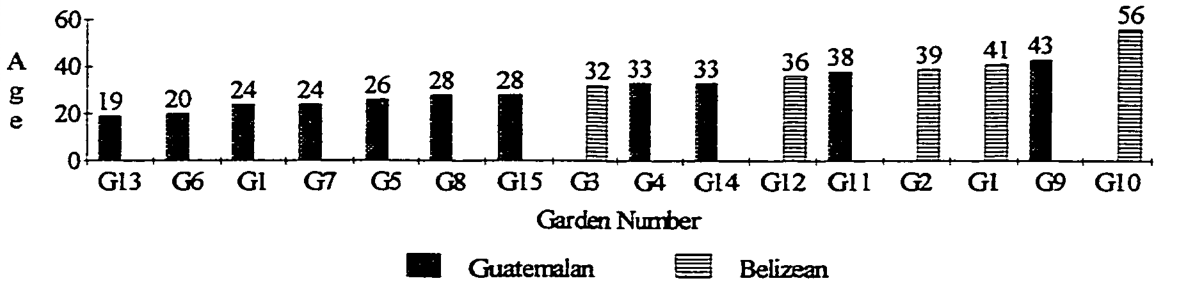
6.2 Gardener/Household (HH) Data

6.2.1 Age

Sixteen women, from 15 HHs (one case where two unrelated women occupy the same HH), were sampled. The average age of the 16 women was 32.5 years of age, with the overall distribution ranging between 19 and 56 years of age from youngest to oldest (see Figure 6.6, below). Thirteen (81.5%) of the 16 women, ranging in age from 19 to 39 years, were of child bearing age, with many continuing to have children into their late 30's.

Gardeners were generally younger than their spouses by approximately 4.5 years (the average age of males being 37 years of age, with a high of 59 and a low of 22 years of age).

Figure 6.6 Age & Origin of Gardeners
(1996)



Age, a variable consisting of categorical data, was tested against dependent and independent variables using two statistical methods. First, correlation analysis was used to identify potentially meaningful associations, indicated by a significant correlation coefficient. Second, simple linear regression was applied to cases where significant correlation coefficients were identified. Although not an ideal method to utilize on a small data set, regression analysis was employed to gain further insight into potential associations and to cross-check the validity of the results from the correlation analyses.

Results of the correlation analysis indicate that the Age variable was not statistically significant with respect to the dependent variables: the number of species in home gardens (Species) and the number of plants in home gardens (Plants) (Table 6.9, page 111). This suggests that the age of gardeners is not related to the structure (defined by the dependent variables) of San Lucas home gardens. However, the two dependent variables (Species and Plants) did not show strong relationships with many of the independent variables tested, with the exception of Education, Residence and some of the function category variables (Table 6.9, page 111).

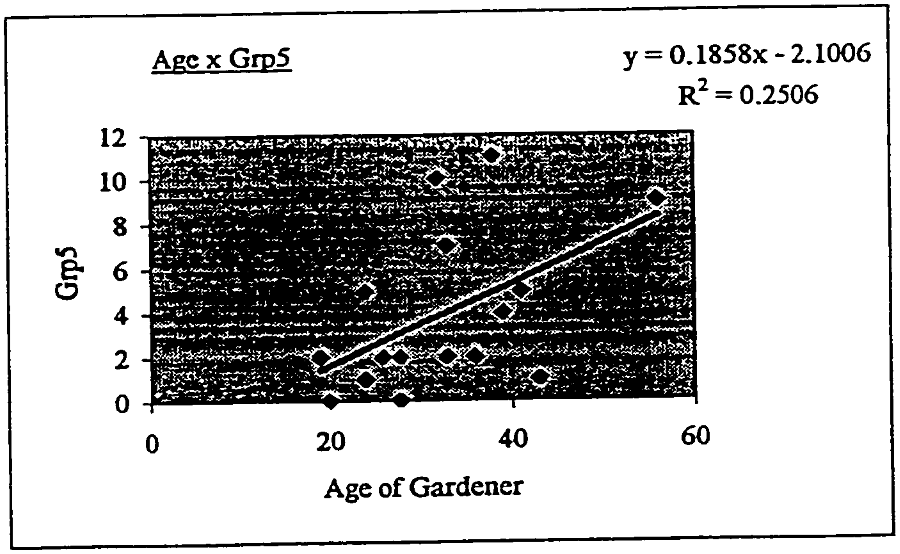


Figure 6.7 Age of Gardeners x Grp5 (medicinal woody perennials)

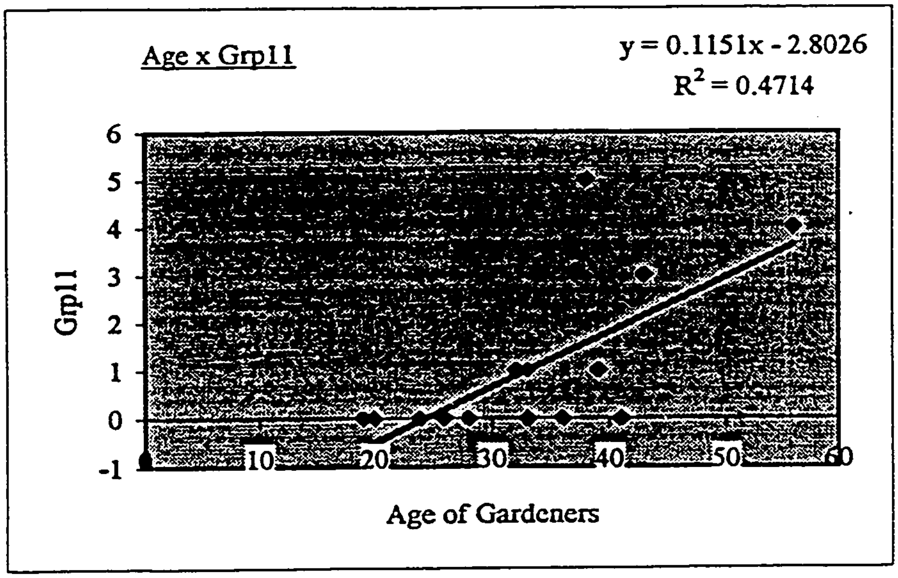
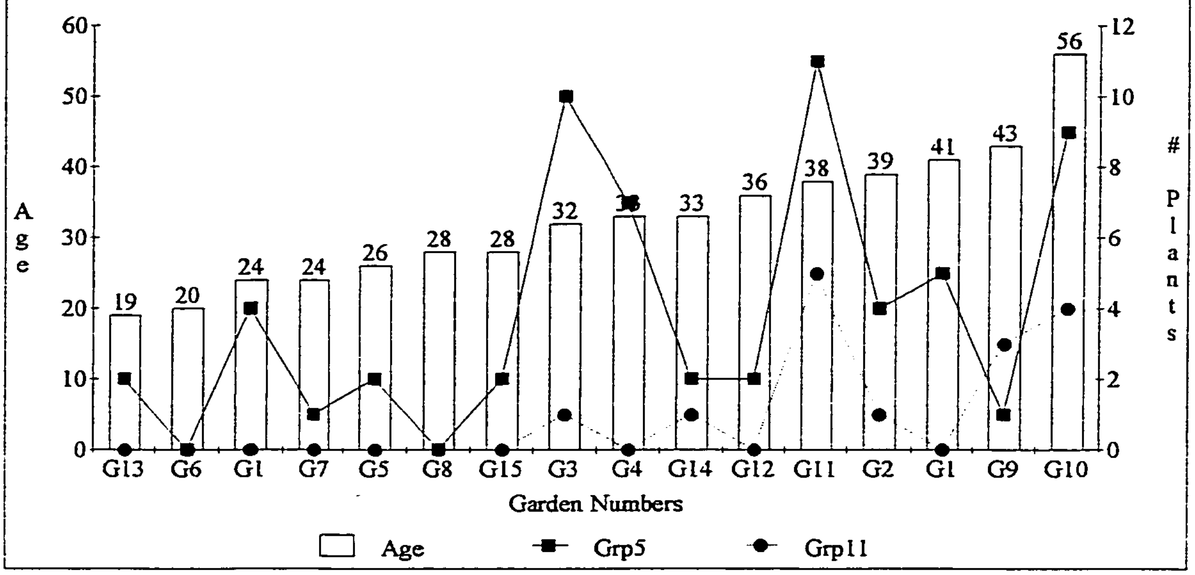


Figure 6.8 Age of Gardeners x Grp11 (medicinal shrubs/vines)

However, a correlation coefficient of 0.501* (Table 6.10, page 111) and an r^2 value of 0.25 (Figure 6.7, page 114) suggests that approximately 25% of the variability between the age of gardeners (Age) and medicinal woody perennials (Grp5) was explained by the analysis. Further, a correlation coefficient of 0.687** (Table 6.9, page 111) and an r^2 value of 0.47 (Figure 6.8, page 114) suggests that approximately 47% of the variability between the age of gardeners (Age) and medicinal shrubs/vines (Grp11) was explained by the analysis.

Figure 6.9 Age x Grp5 & Grp11 Plants



Visual representation of the distribution of Grp5 plants (*Persea americana* [avocado] and *Psidium guajava* [guava]) by gardeners age (Figure 6.9, above), with age increasing from left to right, indicates that the significant association suggested by results of the statistical analyses are questionable. Most gardeners viewed both avocado and guava fruits is as sources of food rather than medicines; therefore, any proposed associations between the two variables was refuted by the gardeners themselves.

Again, visual representation of the distribution of Grp11 plants (Figure 6.9, above) by age demonstrates that, regardless of the results of the statistical analyses (Figure 6.8, page 114), no association exists between the age of gardeners in San Lucas and *Gossypium hirsutum* (cotton).

All species contained within Grp5 (*Persea americana* [avocado] and *Psidium guajava* [guava]) and Grp11 (*Gossypium hirsutum* [cotton]) are multi-purpose because they appear in more than one function category. For example, avocado and guava are cultivated for food as well as being available for medicinal purposes while cotton fits into three categories: medicinal, utilitarian and ornamental. Fibres from bols of cotton are used to apply medicines, protect wounds and sore or infected areas as well as for lamp wicks, while the plant itself is enjoyed for the ornamental effect of its flowers and foliage.

6.2.2 Education

The level of formal education achieved by individuals is often used, especially in western societies, as an indicator of experience or intelligence. Although most of the 16 women participating in the study do not have any formal education, this does not suggest that they lack either intelligence or experience. It simply means that levels of formal education are easy for researchers to measure and evaluate, but are not always relevant when applied to people who rely on less formal types of education, such as traditional environmental knowledge (TEK).

Women in the sample who immigrated from Guatemala did not have any formal education, while women who grew up in Belize could attend school up to a Standard 6 level (equivalent to Grade 7 or 8 in Canada) if they lived in a village that had a school. Not all Maya villages in southern Belize had, or have, the benefit of a school and distances between communities often made, or make, daily travel prohibitive for school age children.

Of the 16 women sampled, 14 (87.5%) had no formal education, while the other two (12.5%) completed the highest level of education available to them: Standard 6 in the Belize school system. The two women who have formal education are Belizean nationals and they speak English, although they have lost their ability to read and write in English due to lack of practice.

The level of education possessed by San Lucas gardeners (Education) was tested against the two dependent variables (Species and Plants) and independent variables using correlation analysis (Table 6.9, page 111 and Table 6.10, page 111). For this analysis Education was expressed as "1" for those gardeners with formal education and "2" for those gardeners without formal education. For the purpose of this study, formal education is defined as a curriculum-based educational program, such as those offered at a centrally located and government sanctioned school.

Results of the correlation analysis indicated that the level of education possessed by gardeners (Education) showed no significant correlation with the number of species (Species) found in each home garden (Table 6.9, page 111). However, a correlation coefficient of 0.635** (Table 6.9, page 111) indicates that approximately 32% of the variability, between 'Education' and the number of individual plants (Plants) in home gardens, was explained by the analysis. My field observations and data collected from focus group discussions and interview schedules challenges the significance of the coefficient, suggesting that the proposed association is not truly representative.

The average number of individual plants found in San Lucas home gardens is 92, with a range of 16 to 512 (Figure 6.10, below and Appendix B, page 181). The only two women in San Lucas with formal education garden at sites G3 and G12. The plant count for garden G3 (512 individuals) greatly exceeds that of other San Lucas home gardens and is probably affecting the analysis. The situation at site G3 is more the result of when the garden was established and how it was developed, rather than the level of education possessed by the current gardener. The G3 site was purchased by the current gardeners' family from the woman who developed the garden over a period of 10+ years. It is the garden with the longest history of cultivation and as such it is not surprising that it also has a preponderance of mature economic species and the highest count of individual plants.

Figure 6.10 Gardeners Education x Number of Plants

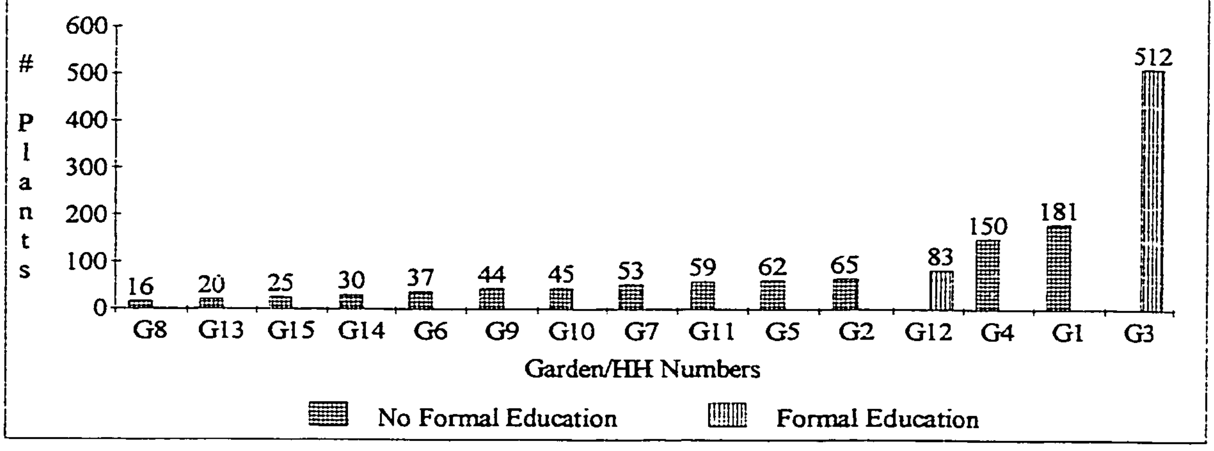


Figure 6.10, above, provides a visual indication of the distribution of plants among home gardens and delineates between those gardeners with and without formal

education. It is evident from examination of this bar chart that, even with the removal of garden G3 from the analysis, the level of education possessed by San Lucas gardeners (Education) is not associated to the number of plants cultivated in their home gardens (Plants).

Results of further correlation analysis indicated the following associations between the variable 'Education' and other independent variables (Table 6.10, page 111):

- Education x Grp1 (edible woody perennials) .691**
- Education x Grp3 (cash crop woody perennials) .701*
- Education x Grp6 (woody perennials used for shade) .628*
- Education x Grp10 (ornamental shrubs/vines) .553*

The associations indicated above, although seemingly significant, probably are not due to the species structure and exceptionally high plant counts found in garden G3, a result of the lengthy history of the garden. As stated previously, the two women with formal education garden at sites G3 and G12. Statistical analysis of Grp1 (edible woody perennials) and Grp3 (cash crop woody perennials) are influenced by the preponderance of *Theobroma cacao* (cacao) trees (up to 300 individuals) found in garden G3; a number far in excess of other gardeners in the village (Appendix B, page 181). Other gardeners, including the woman at G12 with a count of 38 edible woody perennials (Grp1) and 17 cash crop woody perennials (Grp3) in her home garden, fall within the following ranges for San Lucas home gardens:

- Edible woody perennials (Grp1): range: 2 to 84 individual plants
- Cash crop woody perennials (Grp3): range: 1 to 39 individual plants

Again, counts for garden G3, in both Grp1 and Grp3 categories, noticeably exceed the range of other gardeners in San Lucas. Both categories include the multipurpose tree - *Theobroma cacao* - which, because it is found in such high numbers in garden G3 (approximately 300 individuals), is probably influencing the analysis. Further, the number of plants from garden G12, managed by the only other gardener with formal education, falls within the range present in other San Lucas gardens. These factors suggest that the level of education possessed by gardeners (Education) is not associated with the number of edible woody perennials (Grp1) and cash crop woody perennials (Grp3) found in San Lucas home gardens.

The correlation between 'Education' and woody perennials used for shade (Grp6) is also affected by the presence of *Theobroma cacao* (cacao) trees in garden G3. Although woody perennials present in San Lucas home gardens are used to shade HH structures, people, animal enclosures, pathways, seedbeds and work areas, the majority of Grp6 species in garden G3 are used to shade *Theobroma cacao*; where approximately 300 individuals are cultivated. Because *Theobroma cacao* requires shade for optimum growth it can be expected that a garden with so many cacao trees would have a correspondingly high count of woody perennials to provide the shade required. Therefore, an association between the level of education possessed by gardeners (Education) and the number of woody perennials used for shade (Grp6) is unlikely mainly because of the disproportionately high number of shade species found in garden G3.

To reiterate, the presence of such a high number of *Theobroma cacao* trees in garden G3 probably affected the entire analysis between the level of education possessed by gardeners (Education) and the variables: Grp1, Grp3 and Grp6.

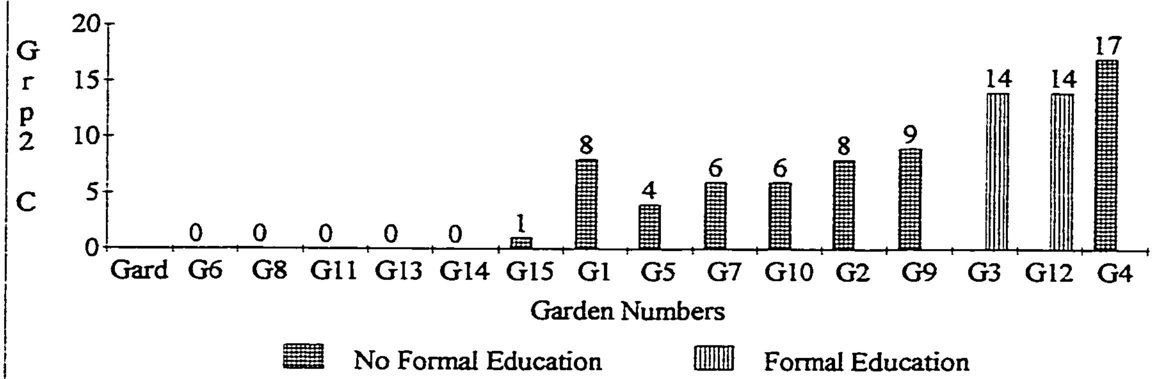
The seemingly significant correlation between the level of education possessed by gardeners (Education) and the number of ornamental shrubs/vines (Grp10) in San Lucas home gardens is likely deceptive because the two gardeners possessing formal education (G3 and G12) are at opposite ends of the range counted for Grp10 plants. The gardener at G3 had a count of 22 individual plants, while the gardener at G12 had no (zero) plants (Appendix B, page 181). Based on this, it is unlikely that level of education possessed by gardeners is associated to the number of individual *Gossypium hirsutum* (cotton) and *Hibiscus* spp. (hibiscus) (the only two species included in the Grp10 category) plants found in San Lucas home gardens.

Significant correlations were indicated between the variable 'Education' and other independent variables (Table 6.10, page 111) as follows:

- Education x Grp2 (utilitarian woody perennials) .533*
- Education x Grp17 (medicinal crops/herbs) .543*

The correlation between 'Education' and utilitarian woody perennials (Grp2); *Orbigyna cohune* (cohune palm), *Crescentia cujete* (calabash) and *Swietenia macrophylla* (mahogany); seems possible because both gardeners with formal education, gardening at G3 and G12, have Grp2 counts of 14. These counts are at the higher end of the range for San Lucas home gardens (0 to 18), with only one other gardener (G4) having a higher Grp2 count. Examination of Figure 6.11, below, provides visual evidence that there may be other factors at play here. Although both gardeners with formal education have high Grp2 counts, I propose that much of the seeming significance results from three other factors.

Figure 6.11 Gardeners' Education x Grp2 Plant Counts



First, many of the gardeners who have high counts of utilitarian woody perennials (Grp2) have extensive zone two garden areas (see Section 2.0 for further information), where the distribution of cohune palms, in particular, is often dense. Second, cohune palms are also counted as woody perennials used for shade (Grp6) (Table 6.3, page 92), which means that gardens containing species that require shade (i.e., *Theobroma cacao* in garden G3) would probably be utilizing a number of cohune palms for this purpose. Unfortunately, the multipurpose nature of the cohune palm is probably influencing the statistical analyses. Finally, management strategies selected by gardeners and/or their spouses may be reflected in analysis. I am referring to garden G1, where the MHH has planted mahogany trees that have nothing to do with the livelihood strategies selected by the FHH.

Kekchi women use leaves from cohune palms (*Orbigyna cohune*) to make utilitarian items, such as brooms, wrapping for food when travelling and to line home garden seedbeds; while calabash fruit (*Crescentia cujete*) is used to fashion bowls for HH use. These items are used daily in all HHs, by all women, regardless of the level of education they possess. *Swietenia macrophylla* (mahogany), the third species found in the Grp2 category, is normally not used by Kekchi women but by Kekchi men as construction material (see section 6.4.2, page 149).

A correlation coefficient of 0.543* indicated a seemingly significant association between the level of education possessed by gardeners (Education) and medicinal crops/herbs (Grp17: *Cymbopogon citratus* [lemon grass] and *Sanseviertia trifasclata* [snake plant]) (Table 6.10, page 111). However, a visual examination of the distribution of these plants in San Lucas home gardens may provide an alternate view.

Figure 6.12 Gardeners' Education x Grp17 Plant Counts

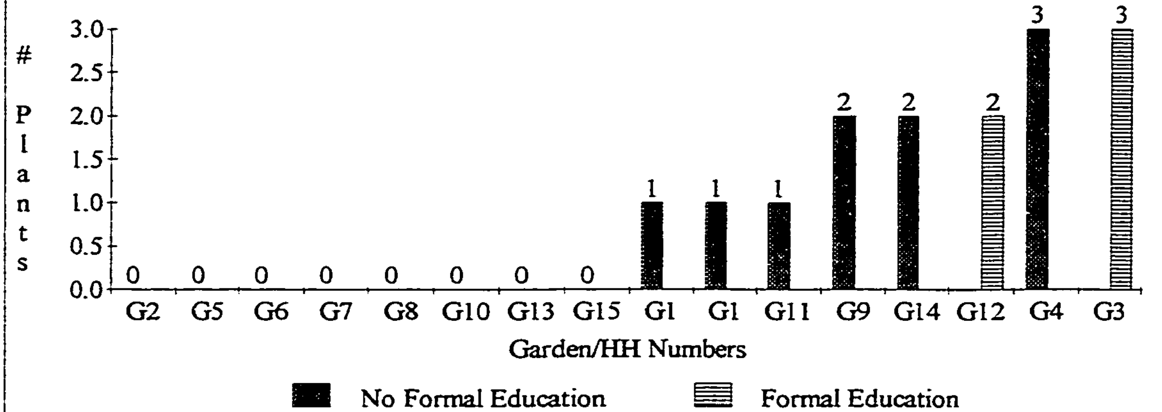


Figure 6.12, above, shows that eight (50%) San Lucas gardeners grow Grp17 plants in their home gardens. All eight producing gardeners grow *Cymbopogon citratus*, while only two grow *Sanseviertia trifasclata*. Further, only two of the eight gardeners who grow Grp17 plants possess any formal education and neither of these women grow *Sanseviertia trifasclata*. A look at the bar chart does not provide convincing evidence of a significant correlation. For instance, gardeners, both with and without formal education, grow Grp17 plants in their home gardens and in similar numbers. If the level

of gardeners' education is not influencing the decision to include *Cymbopogon citratus* (lemon grass) and *Sanseviertia trifasclata* (snake plant) gardens, then what other explanations are there? An interesting possibility involves kinship ties within the community.

As it happens, all gardeners who did not grow their own Grp17 plants did, in fact, have strong kinship ties to village gardeners who did grow these plants! The gardener at G3, for example, has a sister at G8 who does not grow Grp17 plants. This sister is married to the oldest of four brothers living at garden sites G5, G6 and G7, also where no Grp17 plants are present; hence, all of these HHs have access to *Cymbopogon citratus* (lemon grass) and *Sanseviertia trifasclata* (snake plant), through gardener G8s relationship to gardener G3. The gardener at G10 may obtain Grp17 plants from either her daughter-in-law (G1) or her daughter (G12). Finally, the gardener at G2 is able to obtain Grp17 plants from her mother-in-law. Although G2s mother-in-law declined to participate in the study, I was able to make a visual identification of Grp17 species in her garden; thereby, noting where gardener G2 could obtain these plants if they were required.

Interestingly, the gardener at G3 is the wife of the community health worker and the gardener at G12 is the sister of the same man. Coincidentally, these women are the only two San Lucas gardeners who have formal education; however, the number of medicinal crop/herb plants (Grp17) in their home gardens is not significantly higher or lower than the numbers found in the gardens of the other six gardeners who cultivate Grp17 species in their gardens.

6.2.3 Household Size and Breakdown

The following four independent variables (6.2.3.1 to 6.2.3.4) present data related to family size. These were included in the analysis with the idea that perhaps family size would influence the structure and possibly the function of home gardens. For example, it was postulated that a gardener who is raising several young children may not have the time to devote to extensive home garden pursuits. Such a garden may have low species composition and plant counts, emphasizing subsistence foods for HH consumption. Conversely, a woman with a large family and several older daughters may have a more structurally complex garden than some of her neighbours, including more cash crops, because she can utilize the labour of her daughters.

6.2.3.1 Totalkid

'Totalkid' refers to the number of gardeners' children, both female and male, currently residing in each gardeners HH. Totalkid, a variable consisting of categorical data, was tested against dependent and independent variables using two statistical methods. First, correlation analysis was used to identify potentially meaningful associations, indicated by a significant correlation coefficient. Second, simple linear regression was applied to cases where significant correlation coefficients were identified. Although not an ideal method to utilize on a small data set, regression analysis was employed to gain further insight into potential associations and to cross-check the validity of the results from the correlation analysis.

Results of the correlation analysis indicated no significant associations between the number of gardeners' children residing in the HH (Totalkid) and the dependent variables: Species and Plants (Table 6.9, page 111). However, a correlation coefficient of 0.506* (Table 6.10, page 111) and an r^2 value of 0.256 (Figure 6.13, below) suggests that approximately 25% of the variability between the number of gardeners' children residing in each HH (Totalkid) and the number of medicinal crop/herb plants (Grp17) in San Lucas home gardens was explained by the analysis.

Results of both the correlation and the regression analyses suggest that there is a weak relationship between the number of gardeners' children residing in a HH (Totalkid) and the number of medicinal crop/herb plants (Grp17) cultivated in home gardens. However, the distribution of Grp17 plants (*Sanseviertia trifasclata* [snake plant] and *Cymbopogon citratus* [lemon grass]), pictured in Figure 6.14, below, provides evidence to the contrary.

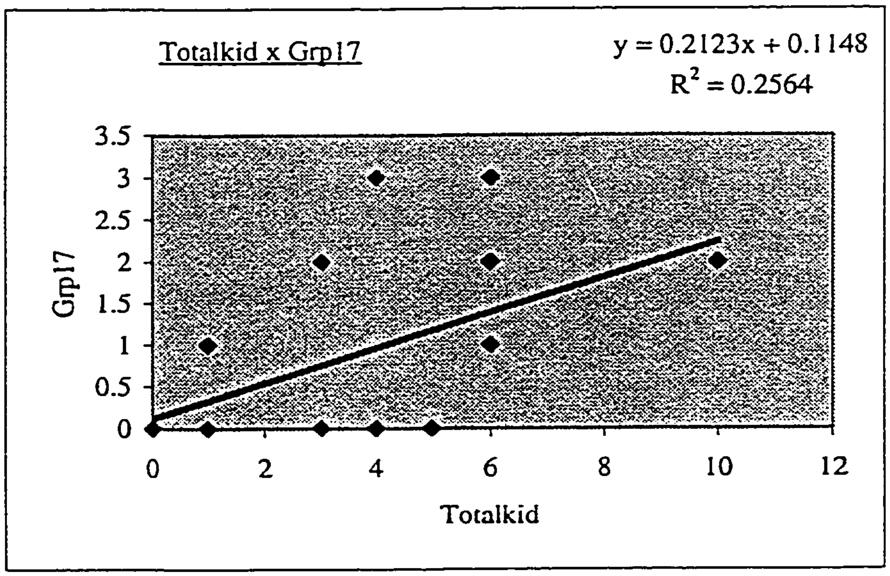
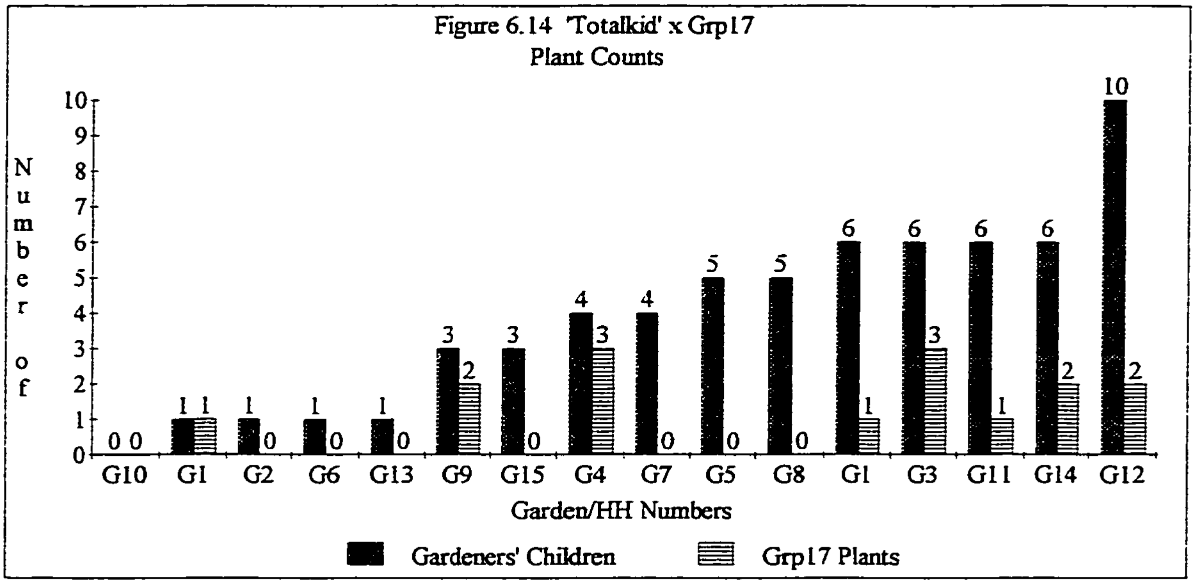


Figure 6.13 'Totalkid' x Grp17 (medicinal crops/herbs)



Some participants told me that snake plant has properties useful in the treatment of snake bites, while lemon grass is commonly made into a tea and consumed for relief of cold, "flu" and stomach-related ailments. It should not be considered unusual that HHs containing a higher number of children would have these species readily available in case of sickness. Those HHs containing fewer children, however, would be able to obtain both of these medicinal plants from the home gardens of relatives or friends in San Lucas by way of trade, a gift or by purchasing the plants. Therefore, it would not be absolutely necessary for gardeners to add these two species to their own gardens until their family expanded.

Although the village of San Lucas contains a new government Health Post, constructed in 1996, there is no permanent health care worker posted to the village. As such, the villagers are responsible for treating minor ailments. A registered nurse travels through San Lucas and other isolated villages every six to eight weeks to give babies and children vaccinations and to treat minor ailments. The closest medical professional, a health care worker, is located two villages away (two to three hours walking). For major medical problems villagers must travel approximately 50 kilometers to the district capital of Punta Gorda where there are doctors and a hospital.

6.2.3.2 Girls

The variable, Girls, refers to the number of gardeners' female children, 8+ years of age, currently residing in each gardeners HH. Girls, a variable consisting of categorical data, was tested against dependent and independent variables using two statistical methods. First, correlation analysis was used to identify potentially meaningful associations, indicated by a significant correlation coefficient. Second, simple linear regression was applied to cases where significant correlation coefficients were identified. Although not an ideal method to utilize on a small data set, regression analysis was employed to gain further insight into potential associations and to cross-check the validity of the results from the correlation analyses.

During the early stages of the investigation study participants told me that, in general, girls eight years of age and older contributed to the HH labour pool and had responsibilities ranging from caring for younger siblings, supplying the HH with water for cooking, gardening, animal care, etc.. For this reason the variable Girls was included in the analysis to test whether the added labour provided by female children impacts the structure and/or function of home gardens.

Results of the correlation analysis indicated no significant associations between the number of gardeners' female children, 8+ years of age, currently residing in each gardeners' HH (Girls) and the dependent variables, Species and Plants (Table 6.9, page

111), or most of the independent variables. However, a correlation coefficient of 0.588* (Table 6.10, page 111) and an r^2 value of 0.3459 (Figure 6.15, below) suggests that approximately 35% of the variability between the number of girls, 8+ years of age, residing in each gardeners' HH (Girls) and the number of medicinal crop/herb plants (Grp17) found in San Lucas home gardens was explained by the analysis.

Results of both the correlation and regression analyses could be interpreted to mean that as the number of girls, 8+ years of age, residing in each gardeners' HH (Girls) increases so to do the number of Grp17 plants (*Sansevieriia trifasclata* [snake plant] and *Cymbopogon citratus* [lemon grass]) in San Lucas home gardens.

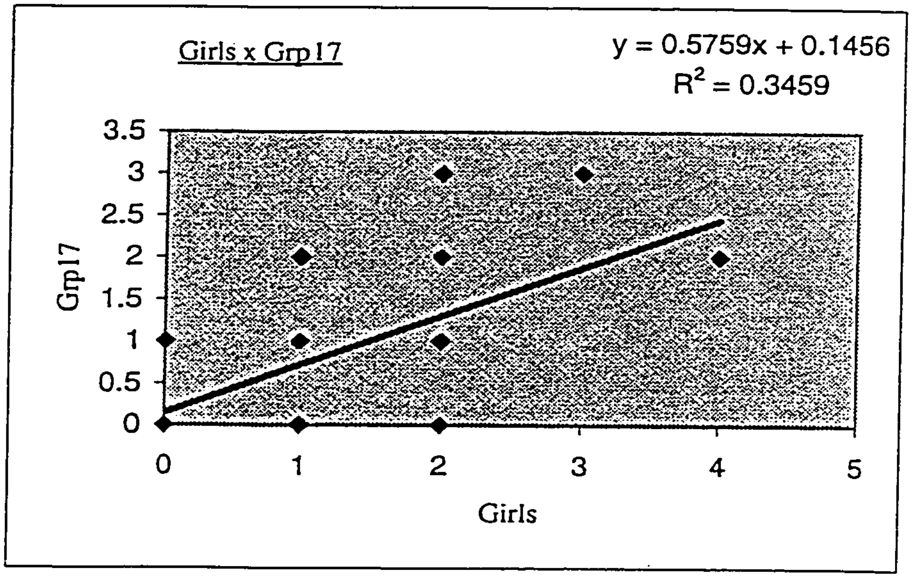
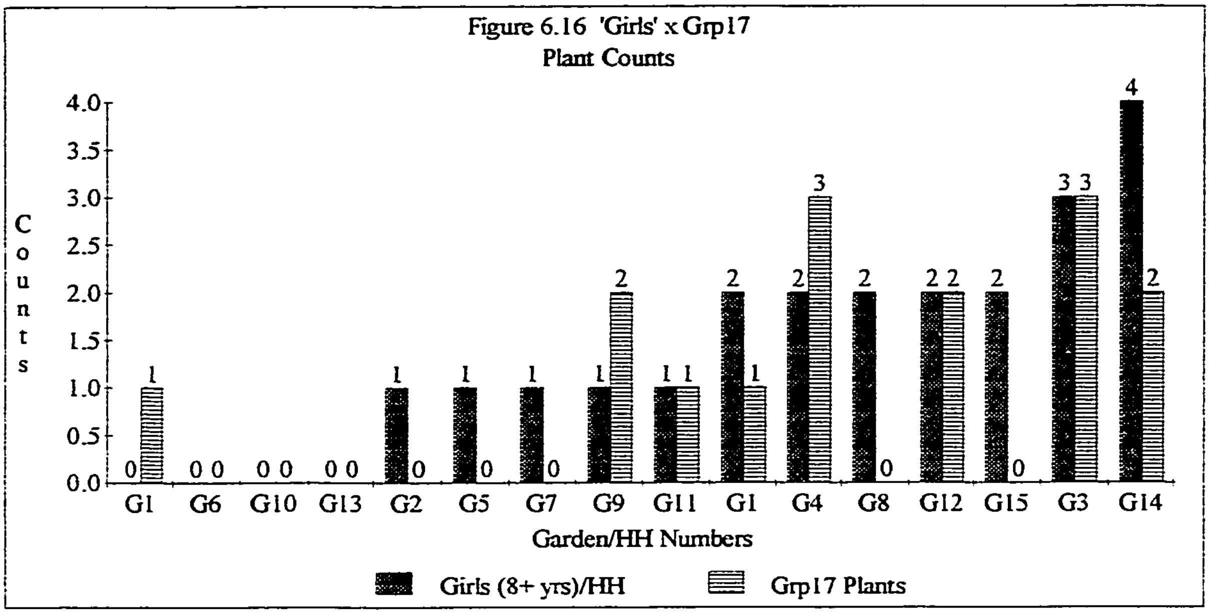


Figure 6.15 'Girls' x Grp17 Plants (medicinal crops/herbs)

However, an examination of Figure 6.16, below, illustrating the distribution of the two Grp17 species (*Sanseviertia trifasclata* [snake plant] and *Cymbopogon citratus* [lemon grass]) in San Lucas home gardens, creates doubt that there is an association. Although it was postulated that the additional labour provided by girls eight years of age and older would allow gardeners to consider modifying their livelihood strategies concerning Grp17 plants in their home gardens it seems that this is not the situation in this case.



6.2.3.3 Kids1

'Kids1' refers to the number of gardeners' female and male children, less than eight years of age, currently residing in the gardeners HH. Because of the categorical nature of the data, correlation analysis was the statistical method employed to test for associations between Kids1, the two dependent variables (Species and Plants) and other independent variables. Results indicated no significant correlation coefficients between (Kids1) and either of the dependent variables or other independent variables (Tables 6.9 and 6.10, page 111). In general, this suggests that the presence of children, less than eight years of age, do not affect the structure or function of home gardens in San Lucas.

6.2.3.4 Kids2

The variable, Kids2, refers to the number of gardeners' female and male children, 8+ years of age, currently residing in the gardeners HH. Kids2, a variable consisting of categorical data, was tested against dependent and independent variables using two statistical methods. First, correlation analysis was used to identify potentially meaningful associations, indicated by a significant correlation coefficient. Second, simple linear regression was applied to cases where significant correlation coefficients were identified. Although not an ideal method to utilize on a small data set, regression analysis was employed to gain further insight into potential associations and to cross-check the validity of the results from the correlation analyses.

A correlation coefficient of 0.627** (Table 6.10, page 111) and an r^2 value of 0.393 (Figure 6.17, below) indicated that approximately 39% of the variability between the number of gardeners' female and male children, 8+ years of age, currently residing in the gardeners HH (Kids2) and the number of medicinal crop/herb plants (Grp17) found in San Lucas home gardens was explained by the analysis. Although these results may suggest that increases in the number of gardeners' female and male children, 8+ years of age, currently residing in the gardeners HH (Kids2) and the number of Grp17 plants (*Sanseviertia trifasclata* [snake plant] and *Cymbopogon citratus* [lemon grass]) found in San Lucas home gardens, evidence presented in Figure 6.18, page below, would seem to dispute this proposition.

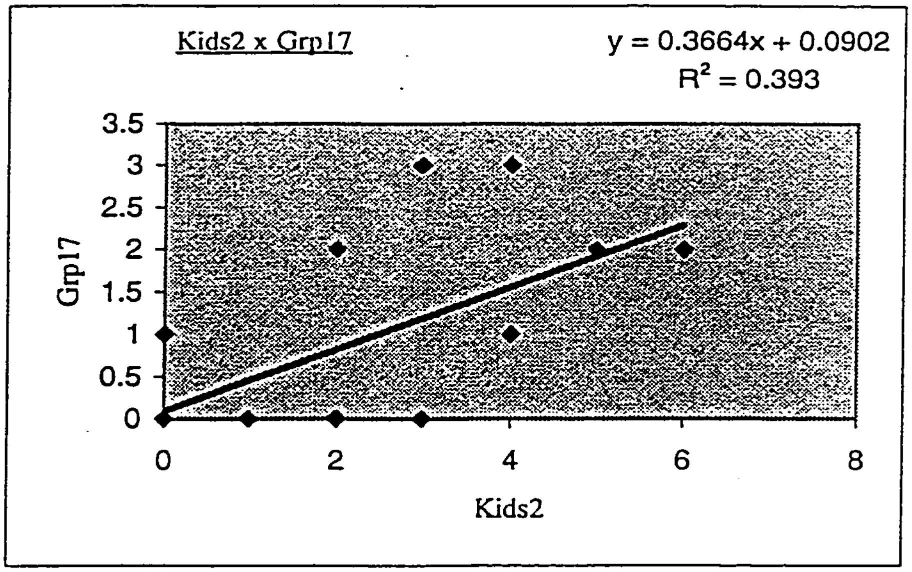
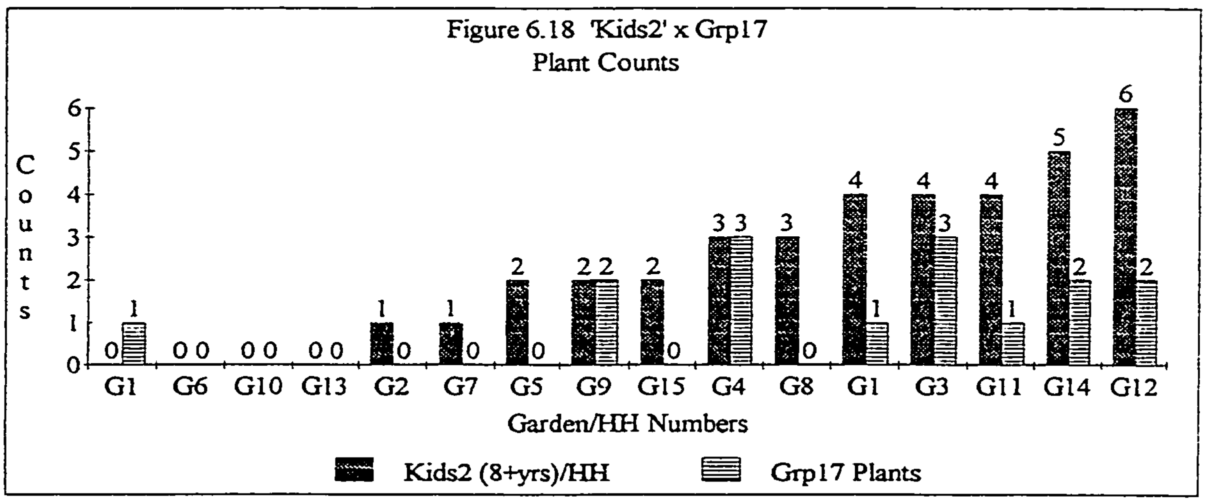


Figure 6.17 'Kids2' x Grp17 Plants (medicinal crops/herbs)



The distribution of Grp17 species (*Sanseviertia trifasclata* [snake plant] and *Cymbopogon citratus* [lemon grass]), illustrated below, demonstrates that there is no association between increases in the number of gardeners' female and male children, 8+ years of age, currently residing in the gardeners HH (Kids2) and the number of medicinal crop/herb plants (Grp17) found in San Lucas home gardens.

6.3 Residence History of Gardeners

6.3.1 Origin

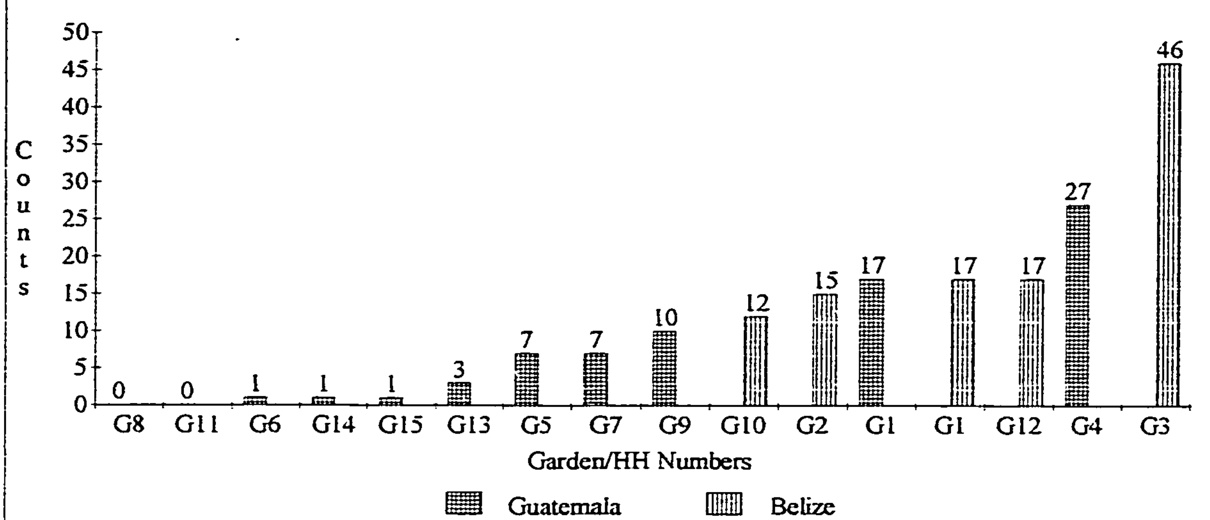
In this study, origin was defined as the country - Belize or Guatemala - where each gardener had spent the majority of her life before moving to San Lucas. Based on observations that I made while working in isolated parts of Chiapas, Mexico, Costa Rica and Venezuela, I believed this variable could be an important factor influencing the complexity of home garden structures in San Lucas. These observations led me to believe that women rely more heavily on their traditional knowledge if they reside in areas where land tenure is uncertain and government and privately sponsored programs of natural resource management are not available. For example, the Maya living in portions of Guatemala, adjacent to Belize, seldom have secure tenure to land, nor do they benefit from government improvement programs. In contrast, the Maya in Belize have access to communal lands as well as agricultural extension programs. Factors such as these may require that the Maya living in Guatemala place more emphasis on their traditional knowledge to make a living. Therefore, any Maya woman who immigrates to Belize and maintains familial ties in Guatemala would continue to have access to her family for purposes of knowledge dissemination and resource exchange. Since the southeastern region of Guatemala and the adjacent portions of southern Belize are similar environmentally, vegetative materials are compatible as well as the knowledge attached to their cultivation. This could give Guatemalan immigrants the advantage of utilizing their traditional environmental knowledge immediately upon settling in Belize, rather than having to adapt to different environmental conditions (i.e., species composition, terrain, soil types, weather conditions).

Eleven (69%) of the 16 women sampled resided in south and eastern departments of Guatemala from birth until they either married a man from Belize or simply crossed the border with members of their family to take up residence in Belize. Data presented in Figure 6.5 (page 110) indicates that a disproportionate number of young women gardeners in San Lucas are originally from Guatemala, while an almost equal proportion of older women are from Belize and Guatemala respectively.

Correlation analysis was the statistical method used to identify potentially meaningful associations, indicated by a significant correlation coefficient. The variable Origin was defined as '1' for Belizean gardeners and '2' for Guatemalan gardeners for the purpose of correlation analysis. No significant correlation coefficients were indicated between Origin and either of the dependent variables, Species and Plants (Table 6.9, page 111), or with any other variables, with one exception. A correlation coefficient of 0.566* (Table 6.10, page 111) indicates that approximately 28% of the variability between the country of origin of gardeners (Origin), either Belize or Guatemala, and the number of individual woody perennials used for shade (Grp6) in San Lucas home gardens was explained by the analysis.

Although the association between Origin and Grp6 species (*Mangifera indica* [mango], *Syzygium malaccense* [malay apple], *Brosimum alicastrum* [breadnut], *Cocos nucifera* [coconut palm], *Orbigyna cohune* [cohune]) appears to be significant, schematic evidence presented in Figure 6.19, following, refutes this notion. It seems evident that the gardeners' origin is not correlated with the number of woody perennials used for shade (Grp6) in home gardens. In addition to the extraordinarily large number of woody perennials used for shade (Grp6) found in garden G3, differing livelihood strategies selected by gardeners, probably influenced the analysis.

Figure 6.19 'Origin' x Grp6
Plant Counts



6.3.2 Residence

Data concerning residence is indicative of the length of time (in months) the gardener has resided in San Lucas. This was determined to be a potentially important factor when assessing the complexity of home gardens since it is unlikely that newer residents would have a wide variety of species represented in their gardens. It is more likely that pre-established economic species (pre-dating the current gardeners' efforts) and immature (non-bearing) species would predominate.

The variable, Residence, is comprised of categorical data and was tested against dependent and independent variables using two statistical methods. First, correlation analysis was used to identify potentially meaningful associations, indicated by a significant correlation coefficient (Table 6.11, below). Second, simple linear regression was applied to cases where significant correlation coefficients were identified. Although not an ideal method to utilize on a small data set, regression analysis was employed to gain further insight into potential associations and to cross-check the validity of the results from the correlation analyses.

Table 6.11 Correlation Coefficients: Residence x Functional Groups

DEPENDENT VARIABLE	**INDEPENDENT VARIABLES**				
	Grp1	Grp2	Grp3	Grp5	Grp6
Residence	.142	.322	.044	.273	.358
	Grp7	Grp8	Grp10	Grp11	Grp13
Residence	-.262	-.168	-.096	-.077	**.601***
	Grp14	Grp15	Grp17		
Residence	-.113	.441	.067		

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.
Significant correlations appear in bold.

Results of the correlation analysis revealed a significant correlation between the length of time, in months, gardeners have resided in San Lucas (Residence) and the dependent variable, Species (the number of species in San Lucas home gardens), but not with the other dependent variable, Plants, or most of the other variables (Table 6.9, page 111).

A correlation coefficient of 0.593* (Table 6.9, page 111) and an r^2 value of 0.35, (Figure 6.20, following) indicated that approximately 35% of the variability between the length of time gardeners have resided in San Lucas (Residence) and the dependent variable, Species, was explained by the analysis. In other words, the number of species in San Lucas home gardens seems to increase with the length of time gardeners reside in the village managing their home gardens. Further, schematic evidence from Figure 6.21, page 138, seems to provide support for this proposition.

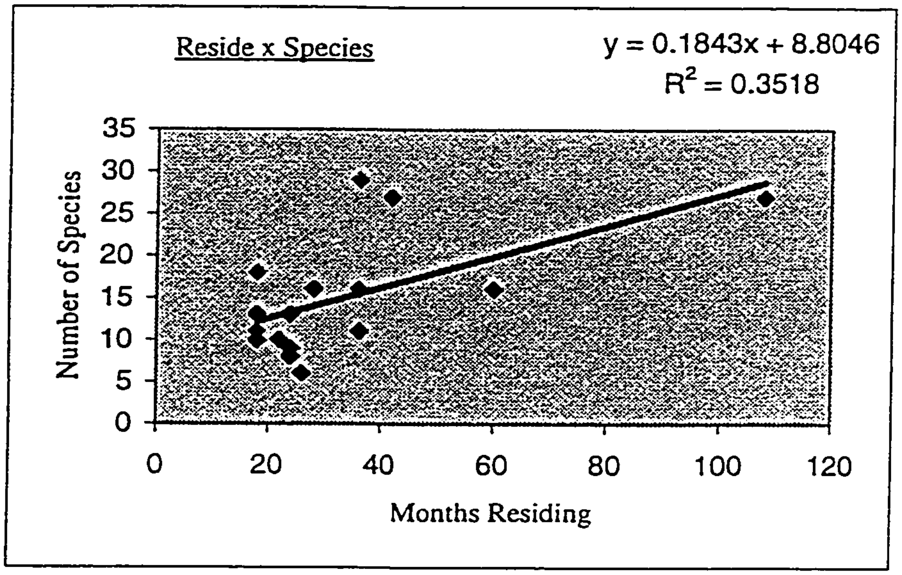
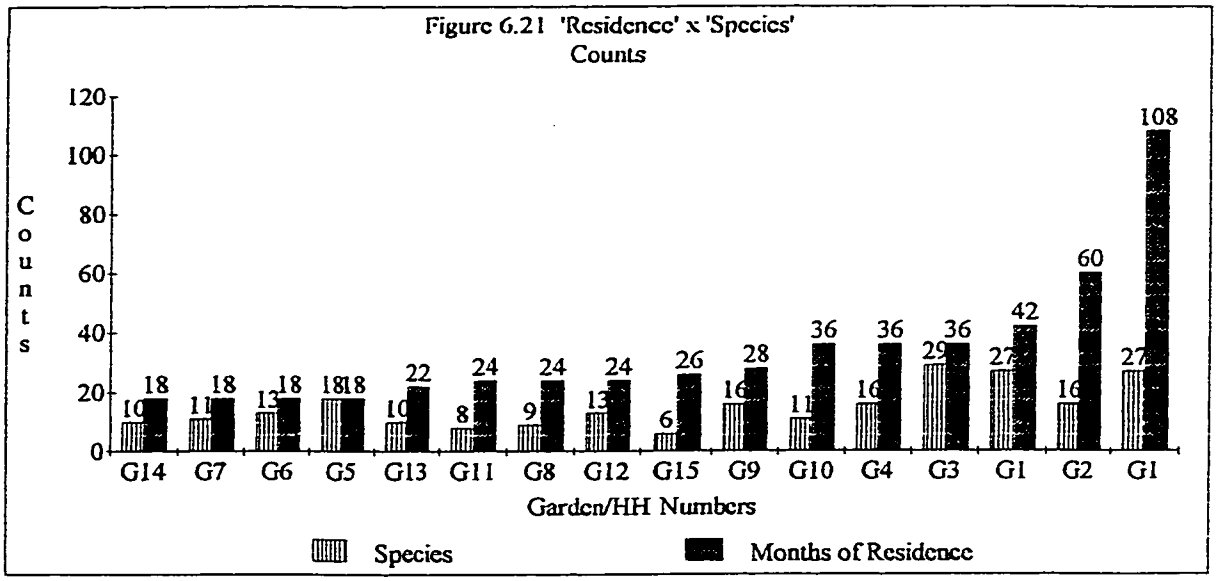


Figure 6.20 'Residence' x 'Species'

The average amount of time that gardeners have resided in San Lucas is short, approximately 33 months (2.8 years), while the range is between 18 months (1.5 years) and 108 months (9 years) (Figure 6.21, below).

A correlation between the length of time (in months) gardeners have resided in San Lucas (Residence) and the number of edible crop/herb plants (Grp13) in San Lucas home gardens was also identified. A correlation coefficient of 0.601* (Table 6.11, page 136) and an r^2 value of 0.61 (Figure 6.22, page 138) indicated that approximately 60% of the variability was explained by the analysis. These results suggested that as the length of time a gardener resides in San Lucas (Residence) increases the number of edible crop/herb plants (Grp13) also increases.



Average number of months residing in San Lucas = 33.6 years = 2.8

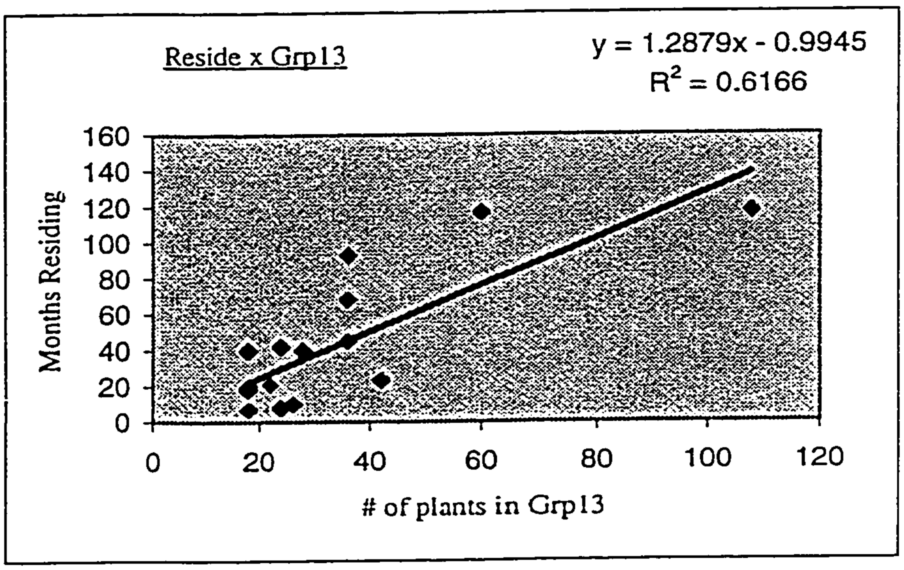


Figure 6.22 'Residence' x Grp13 Plants (edible crops/herbs)

Figure 6.23 'Residence' x Grp13
Plant Counts

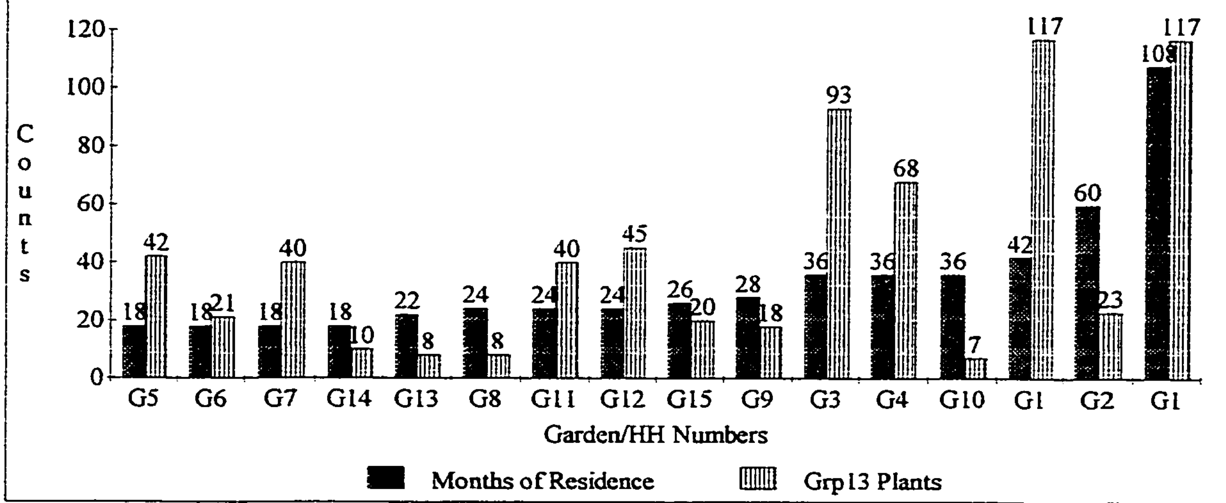


Figure 6.23, above, illustrates the length of time, in months, that gardeners have resided in San Lucas (Residence) and the distribution of edible crop/herb plants (Grp13) in participating village home gardens (G1 to G15). Visually, the chart gives the impression that the number of months that a gardener has resided in San Lucas is not associated with the number of Grp13 plants in village home gardens. However, results of statistical analyses, in combination with extenuating circumstances, examples of which are described below, lend some credibility to the notion that a significant relationship does exist.

San Lucas, for the most part, was very recently re-inhabited; with most gardeners having lived in San Lucas between 18 and 60 months, or 1.5 to 4 years, with the exception of the family at garden G1 who had lived in the village for 108 months, or 9 years. Since most of the gardeners were relatively new to the village the differences in number of edible crop/herb plants (Grp13) recorded from their home gardens could be explained in a variety of ways. Firstly, a few of the edible crop/herb plants found in home gardens (i.e., perennials such as cassava, cocoyam, lemon grass, cilantro) quite possibly pre-existed the management efforts of the current gardeners. A good example of this is garden G3, where the current gardener and her family purchased the site from the woman who established the garden. However, other gardeners may also have a significant number of pre-existing edible crop/herb plants in their gardens since the current village site had been widely inhabited in the 1960s (see Chapter 4 for village history). It is possible that plants utilized by previous residents could have remained at the site and were subsequently conserved during more recent land clearing efforts.

Secondly, gardeners also select different combinations of livelihood strategies to meet their objectives. An example of strategy selection is found among the gardeners at G5, G6 and G7. They are sisters-in-law, they live on adjacent home garden sites, two have very small milpa gardens (plantations), their husbands cultivate joint milpas (see Chapter 4) and these three brothers engage in wage labour opportunities away from the village. These three women cultivate a high number of edible crop/herb plants in their home gardens, compared to other gardeners who have lived in the village for an equivalent amount of time and slightly longer (Figure 6.23, above). This is probably a function of limited female mobility that is enacted, to satisfy social norms, when husbands (MHH) are away for several days or weeks at a stretch. During such periods, women seldom, if ever, travelled to their milpas or milpa gardens to harvest food stuffs; they relied mainly on food stockpiled in their houses and plants which could be found close at hand, such as those in their own home gardens. Gardeners whose husbands did not leave the village to seek wage labour opportunities, selected different combinations of livelihood strategies which included planting larger milpa gardens and smaller numbers of edible crop/herb plants in their home gardens.

Finally, gardeners often cultivated a higher number of edible crop/herb plants to satisfy family obligations. An example of this occurred with the gardener at G3. Her husbands older parents lived on a small home garden site (G10) adjacent to garden G3. Gardener G3 provided her mother- and father-in-law with many types of edible crop/herb plants from her own garden, while her husband cultivated a joint milpa with his father (G10) and a brother (G15). This provides a partial explanation as to why so few edible crop/herb plants were found in garden G10 and so many were recorded in garden G3.

Based on the examples above, it is important to acknowledge and understand that factors, both recognized and unrecognized, functioning dependently and independently of one another, impact the combination of livelihood strategies selected by gardeners/HH members and, hence, the structure and function of home gardens in San Lucas. Mitigating circumstances, such as those presented above, should be included in the interpretation of data, thereby offering explanations for specific cases. Further, testing a larger sample size could confirm that there is indeed a correlation between Residence and the number of edible crop/herb plants (Grp13) cultivated in home gardens as was suggested by results of both the correlation and regression analyses.

6.4 Traditional Environmental Knowledge (TEK)

Traditional environmental knowledge (TEK) was determined to be important to this investigation because one of the underlying assumptions associated with research involving indigenous peoples is the idea that traditional knowledge plays a significant role in the development of production systems. Knowledge cannot be purchased, rather, it is acquired from the teachings of skilled individuals, with an increase in the producers experience over time. Opportunities for an individual to observe, learn and experiment with different techniques increases as the individual ages and their working knowledge base increases. Environmental knowledge possessed by an individual is also linked to that persons place of birth and upbringing and may be a valuable adaptation tool in a new community provided that similar environmental, cultural and economic conditions prevail. Those possessing more knowledge of a new ecosystem/area than a person from another, environmentally dissimilar, area should have an advantage because time consuming experimentation with plants would not be necessary. A general description of TEK is provided in Chapter 3, section 5.0.

Data concerning traditional environmental knowledge (TEK) was obtained by observing women's activities over the duration of the research period and through focus group and informal discussions. I recorded my observations and then engaged each participating gardener in informal discussions, while they were completing their daily tasks (i.e., gardening, preparing food, travelling to and from milpa gardens and milpas), to ask about the activities that I had observed them doing. During these informal discussions I found out who taught/told gardeners about TEK and how, who gardeners teach/tell and how, when and where the information is used and how often. All of this data was cross-checked in focus group discussions and the entire process repeated, again and again, until I had, what I think of as, a comprehensive understanding of where gardeners learn about TEK, how it is applied and when and how the knowledge is further disseminated.

This body of information had to be organized into a format that would be testable; therefore, I developed a series of four (4) questions (Appendix C, page 183) corresponding to each TEK variable, numbered one through five below. If each gardener provided positive responses to three or more questions per variable, then an overall positive response was recorded for the main TEK variable. The converse is also true for negative responses. Gardener responses, either positive or negative based on the above method, were tabulated for each TEK variable, numbered one through five, below, resulting in a percentage, per variable, of positive to negative responses.

It should be noted that participating gardeners were not asked questions directly; rather, the information that I collected was used to provide the answers. I admit that I introduced a bias - previously knowledge and information about TEK activities - by choosing to approach the problem in this manner; however, the sheer vastness of the information collected, in the form of personal stories, provided a real challenge to organize and explain. For purposes of clarity, I would like to emphasize that participating gardeners did provide me with the information to answer the questions. I did not 'answer' the questions based on my observations alone.

Further, the term traditional environmental knowledge (TEK) is limited, in this study, to those ecological activities directly related to home gardening and milpa agriculture. It is not being used to describe all natural resource management activities that could possibly be undertaken by gardeners in San Lucas.

Table 6.12	Traditional Environmental Knowledge Variables
Variable	Definition/Description
TEK1	Gardener exchanges, trades or gives/receives environmental knowledge and/or plant materials to/from members of her extended family. In other words, the gardener maintains a give and take relationship with members of her extended family (i.e., grandparents, parents, uncles, aunts, siblings). In this study, environmental knowledge refers to those activities directly related to home gardening and milpa agriculture. It is not being used to describe all natural resource management activities.
TEK2	Gardener acquires (i.e., taught by example or hands-on experience) environmental knowledge from an older female family member(s), such as grandmothers, mothers, aunts and sisters. Environmental knowledge refers to anything having to do with natural resource management, with the exception of home gardens.
TEK3	Gardener acquires (i.e., taught by example or hands-on experience) home garden management knowledge from an older female family member(s), such as grandmothers, mothers, sisters, aunts.
TEK4	Gardener acquires (i.e., taught by example or hands-on experience) environmental knowledge from "other" female family members (i.e., younger sisters, cousins and sisters- or mothers-in-law).
TEK5	Gardener acquires (i.e., taught by example or hands-on experience) environmental knowledge from a male family member(s) . It is usually those men who are most closely related to the gardener, such as husbands, grandfathers, fathers, brothers and uncles, who interact with gardeners on a regular basis.

6.4.1 TEK1, TEK2, TEK3 and TEK4

All participating gardeners responded positively (100%) to questions associated with TEK1 through TEK3 and fifteen of the sixteen gardeners responded positively to questions associated with TEK4 (Appendix C, page 183). This was significant because it demonstrated that:

- TEK1 - of all possible interactions gardeners have with others (i.e., government extension personnel, international program personnel, tourists, etc.), 100% of gardeners indicated that family relationships were very influential when it came to the distribution and use of traditional environmental knowledge.

- TEK2 - 100% of gardeners indicated that they acquired environment knowledge from an older female family member(s), such as grandmothers, mothers, aunts and sisters.
- TEK3 - 100% of gardeners indicated that they acquired home garden management knowledge from an older female family member(s), such as grandmothers, mothers, aunts and sisters.
- TEK4 - 93.8% of gardeners indicted that they acquired environmental knowledge from "other" female family members, including younger sisters and more distant relations such as cousins and sisters- or mothers-in-law.

Participant responses to TEK1 questions indicated that, in general, gardeners learned about collecting forest species, home gardening, phases of milpa production and raising animals from members of their immediate family. Rarely were non-family members mentioned regarding the dissemination of environmental knowledge. Gardeners stated that they maintained relationships with family members, specifically female relatives, despite geographic distances and that plants, plant cuttings, seeds, fruits, leaves, etc. were commonly traded or given/received as gifts when they visited family members, whether intra- or inter-village. During these visits, gardeners stated that they discussed home garden species composition (existing and planned), activities and species related to milpa garden and milpa production, as well as any problems that they were having with their animals or plants (i.e., poor productivity, pest infestations, etc.).

All gardeners indicated that they acquired both environmental (TEK2) and home garden knowledge (TEK3) from older female family members, such as grandmothers, mothers, aunts and sisters and from 'other' female family members (TEK4), such as cousins and in-laws.

Gardeners began acquiring environmental knowledge from their older female family members at early ages and were exposed to general HH tasks, such as food preparation and manufacture of brooms and bowls, from the time they were born. From the age of five or six years and onward, gardeners accompanied their mothers, grandmothers, aunts and/or older sisters on visits to milpa plots, milpa gardens to learn about associated activities and identifying and harvesting/collecting items from specific resource areas. When girls reached about the age of eight years, they were included in activities such as clearing vegetation, planting seeds, harvesting crops, collecting copal, nutmeg, allspice, etc., and determining which plants and plant parts were edible, could be used to wrap food or could be used to cure specific sicknesses. This combination of teaching by example and hands-on experience was described by all study participants.

From early ages, usually between four and five years, participant gardeners said that they began assisting their mothers and grandmothers with home gardening tasks. Young girls participation in home garden management generally began with watering plants, harvesting some produce, tending to smaller animals such as chickens and ducks and listening to/learning from discussions between older female family members. Topics may have included activities associated with planting and maintaining home gardens; placement of certain species; preparation of garden produce, including which parts of plants are used for specific purposes (i.e., *Crescentia cujete* [calabash] fruits to make bowls, *Cymbopogon citratus* [lemon grass] leaves for tea, *Carica papaya* [papaya] leaves to tenderize meat, young leaves of *Orbigyna cohune* [cohune] used to make brooms). As girls matured their knowledge expanded as their mothers, grandmothers, sisters, etc. enlisted their assistance with building seedbeds, planting, transplanting, harvesting and preparing plant and animal materials from the home garden.

When girls married and established their own HH compounds, complete with a home garden, they continued to confer with older female family members, and other female family members, regarding the management of their home gardens. Information and vegetation continued to change hands when women met and the next generation of gardeners learned from these interactions.

In this study, relationships between older female family members and maturing girls (i.e., future gardeners) developed over the course of lifetimes, with dissemination of environmental and home garden management knowledge being just one part of these relationships. Indications are that much of the environmental and home garden knowledge possessed by participant gardeners was learned from older female family members, a pattern that appears to repeat from generation to generation.

Participant gardeners rarely cited non-family members, including Ministry of Agriculture (MOA) extension personnel or any other individuals or groups from outside the gardeners' cultural group, as sources of environmental or home garden management knowledge. This is interesting in light of the fact that Belize Ministry of Agriculture (MOA) extension personnel spent some time forming women's groups, complete with appointed Chairwomen, in Maya villages, including San Lucas. Internationally funded projects, focusing on more sustainable forms of production in Toledo Maya villages, required that women's groups be formed as a more effective means of disseminating information and programs to the highest possible number of participants in each village.

Because this type of group formation had been very successful with men, it was probably assumed that similar success would occur with women's groups. Program activities, such as instructing members of women's groups how to grow vegetables in garden plots near their houses, were conducted by MOA extension personnel for the duration of the funding periods. Despite efforts by MOA personnel, the artificially formed women's groups encountered some trouble. Because membership was not voluntary (if women didn't join they could not participate in programs) and the Chairwoman appointed was generally the wife of a village council member, political and social affiliations were challenged, leading to some women being barred from joining village women's groups. A few of the groups split and, in one case, a single village ended up with three women's groups, each containing political and social allies. Eventually projects ended, the flow of information and hands-on demonstrations became less frequent and there remained women who had not been welcome to participate in these programs.

Regardless of the type of MOA programming that was directed at female gardeners, study participants in San Lucas clearly indicated that the bulk of the environmental and home garden management knowledge that they regularly utilized comes mainly from their female family members. This is not to say that components of the MOA programs will not be disseminated among Kekchi Maya women. It simply means that gardeners may unconsciously select information provided by MOA personnel, adjust it to meet their needs, and then it may surface in seasons to come as part of their traditional environmental knowledge. Two good examples of this pattern are gardeners who grow tomatoes in mounds to discourage diseases and pests and the design of seedbeds currently utilized in home garden management. Both can be traced back to MOA extension programs provided to women in several Kekchi Maya villages in the area.

6.4.2 TEK5

The variable,TEK5, refers to the environmental knowledge gardeners have acquired from male family member(s), such as fathers, brothers, uncles and cousins. Correlation analysis was the statistical method used to test for meaningful associations, indicated by a significant correlation coefficient, between TEK5, and other study variables.

Results of the correlation analysis indicated no significant associations between the environmental knowledge gardeners have acquired from male family member(s), such as fathers, brothers, uncles and cousins (TEK5), the dependent variables (Species and Plants) and most of the independent variables, with one exception.

A correlation coefficient of 0.513* (Table 6.10, page 111) indicates that approximately 25% of the variability between the environmental knowledge gardeners have acquired from male family member(s), such as fathers, brothers, uncles and cousins (TEK5) and the number of utilitarian woody perennials (Grp2) found in San Lucas home gardens is explained by the analysis. This apparent association may be valid since all Kekchi Maya women that I observed used two of the three species (*Orbigyna cohune* [cohune palm] and *Crescentia cujete* [calabash]) included in this category to make common HH items (i.e., cohune leaves are made into brooms, used to wrap food for travel to milpas and to line seedbeds located in home gardens, while calabash fruits are fashioned into bowls). However, much of the knowledge related to the use of these species comes from female members of the gardeners family rather than from males, which would refute the association indicated between Grp2 species and knowledge obtained from male family members (TEK5). In addition to this, two of the species in this category (*Swietenia macrophylla* [mahogany] and *Orbigyna cohune* [cohune palm]) are also regularly used by Kekchi men for construction materials: the leaves of the cohune palm to thatch house roofs and mahogany wood for a variety of construction activities. These uses seem to point to a mix of activities that bisect the realms of female and male dichotomies. Although we cannot connect these species to a process of gardeners' knowledge acquisition from male family members; it does seem possible that men are participating in the decision making processes related to home garden management by planting or sparing individuals from the three species included in the Grp2 category.

7.0 HOME GARDENS VS MILPA GARDENS (PLANTATIONS)

Participant observation, focus group discussions, interviews and conversations with individuals revealed that the women in San Lucas have two types of gardens: home gardens, the focus of this study, and milpa gardens (called plantations by the Kekchi), which are located away from the village.

Milpa gardens are usually cultivated on a portion of the same land that a family had previously used for a wet season maize milpa. After the first or second year of maize cultivation, fields are commonly left to fallow, utilized for milpa gardens, planted with ground foods (i.e., *Dioscorea trifida* [yampi], *Colocasia esculenta* [dasheen], *Ipomoea batatas* [sweet potato], *Manihot esculenta* [cassava]) or a combination of all three activities. Wet season maize milpas can be very large, ranging from 1.2 to 3.6 hectares and averaging 1.82 hectares per HH (Appendix A, page 180). A milpa garden may be the same size as the original wet season milpa, but is more likely to be significantly smaller, sharing the original milpa area with a ground food milpa and/or fallow areas. Re-growth on fallow land may also be chopped and burned after a year or two and a milpa garden planted.

Milpa gardens, although generally larger than home gardens, contain few woody perennial species, such as fruit trees. Species components are consistent with other communities in the Maya area (my observations from Mexico, Guatemala and Belize, unpublished), commonly consisting of: *Allium sativum* (garlic), *Allium cepa* (onions), *Lycopersicon esculentum* (native tomato), *Brassica oleracea* (cabbage), *Sechium edule* (chayote), *Capsicum annuum* and *Capsicum frutescens* (peppers), *Amaranthus* spp. (callaloo), *Hibiscus esculentus* (okra), *Cucurbita* spp. (squash), papaya, *Saccaharum officinarum* (sugarcane), *Sabal mexicana* ("jippi joppa", from the Palmae family), banana, plantain and ground foods such as sweet potato, cassava, dasheen and yampi. Some of these species are also cultivated in home gardens. During focus group discussions and visits to plantations and 'the bush' women indicated a variety of reasons for having both home and milpa gardens (see Appendix F, page 199, for un-ranked list). These ranged from the quality of soils and space available for home gardens to domestic animal predation of species if located in home gardens and the desire to leave the village for a few hours to tend to their plantations.

Evidently, emphasis is placed on milpa or home gardens depending upon commitments that the women have as well as the environmental conditions (i.e., too wet, too dry) in the area where the home garden/HH is located and the impact of free-ranging domestic animals. For example, a woman who has many young children may be prevented, due to child care responsibilities, from going to her milpa garden on a regular basis. Although, women generally form family groups to go to their plantations, taking turns remaining in the village to care for their children and the children of other women. The problem of domestic animals preying on plants in the home garden could certainly be an impetus for cultivating a wider variety of species in milpa gardens.

On average, women visit their plantations (including trips to maize and ground food milpas as well) one to three times each month depending on the type of seasonal and casual activities requiring their attention and time available for these excursions. Multiple tasks are usually conducted on the plantation, making it almost impossible to measure specific amounts of time devoted to each task. For example, it is not uncommon for a full day trip to include collecting sap from the *Protium copal* tree for incense (best undertaken at the beginning of the wet season), harvesting different types of wild fruits, seeds and leaves used in the HH for utilitarian purposes, including as culinary spices, as well as replanting non-germinating milpa garden species, weeding and harvesting of milpa species. Food is taken and the entire day spent completing various activities. Most women make these day long journeys with one or more companions and children of varying ages.

Wilk (1991) recorded that women in the Maya village of Aguacate visited their fields zero to three times monthly and that women from the Maya village of Indian Creek (both villages are located in Toledo District) rarely visited their fields. It was not mentioned whether these fields were milpa gardens (plantations) or maize, rice or ground food milpas. Significantly, San Lucas women made roughly the same number of trips to the fields as women in Aguacate whereas women from Indian Creek cited rare trips to the fields. It is possible that the location of Indian Creek along the southern highway and adjacent to large banana plantations may supply reasons for this difference. The villages of San Lucas and Aguacate are located further away from main roadways than Indian Creek thus, as postulated earlier, the latter is more likely to be closely tied to the larger market and wage economy of the district.

Women from all of these villages acknowledge that they participate in the crucial stages of agriculture where labour bottlenecks, such as planting and harvesting, commonly occur (Table 6.1, page 86).

CHAPTER SEVEN

I. CONCLUSIONS AND RECOMMENDATIONS

1.0 INTRODUCTION

This study focused on the agroforestry practice of home gardening in the Kekchi Maya village of San Lucas, located in the Toledo District of southern Belize, Central America. A gender perspective was stressed over the course of the research since women were the principal home garden managers. Conducted over a period of 12 months, the purpose of the study was to relate selected socio-economic and cultural factors, that may influence the decision making processes of gardeners, to the structure and function of their home gardens. In doing so it was expected that some, or all of the selected factors would provide development professionals and local extension personnel with a better understanding of some of the forces that may motivate gardeners to adopt and modify, or to reject new and/or different scientific technologies when selecting livelihood strategies. An increased understanding of motivational forces is a tool that can be used by development professionals and extension personnel when collaborating with local Maya subsistence and semi-subsistence producers in exploring sustainable alternatives and modifications to their traditional means of production. Alternatives and modifications are sought to mitigate the worsening problem of land pressure in Toledo District, offering a more sustainable approach to natural resource management.

2.0 CONCLUSIONS

Study findings indicated that livelihood strategies selected by HHs, dual zonation of home gardens, gardeners intra- and inter-community kinship ties and land tenure impacted home garden structure and function. The Kekchi Maya women residing in San Lucas (FHHs) were generally responsible for food preparation, collection and/or cutting of fuel wood, supplying the HH with potable water and for the bearing and raising of children. Women's livelihood objectives varied, but all emphasized strategies for the production of food and utilitarian items for the maintenance of HHs, as well as activities designed to procure some cash income. Differences in livelihood objectives were reflected in home garden structure and function. For instance, gardeners identified six function/use categories for the species in their home gardens as follows: edible/food, utilitarian, cash crop, medicinal, ornamental and shade species, which I further grouped by plant structure, corresponding to vertical layering visible in home gardens, as follows: woody perennial, shrubs/vines and crops/herbs. Analysis of this data indicated that species cultivated for food predominated, provided convincing evidence that the principal function of all San Lucas home gardens was the production of food for HH consumption.

As the principal garden managers, women, with the assistance of their resident daughters and daughters-in-law, made the majority of the decisions regarding the structure, function and distribution of outputs from their home gardens. Gardeners devoted an average of one hour daily to home gardening activities with tasks including, but not limited to: constructing seedbeds, transplanting seedlings, planting seeds, watering, weeding and harvesting. Tasks varied according to season and the production cycles of home garden species. The amount of time women devoted to specific tasks was treated as though these activities were mutually exclusive, rather than overlapping. In other words, women could be doing two activities simultaneously and this was not differentiated during compilation and presentation of data.

San Lucas home gardens averaged 0.36 hectares in size, a figure within the range cited for other home gardens around the globe (Fernandes and Nair, 1990; Budowski, 1985; Ninez, 1985; Allison, 1983), with all comprised of two contiguous zones, one well cleared area adjacent to HH structures and a second extending beyond the cleared area into the forest edge. Many of the species found in the forest edge zone pre-existed the home gardens being studied, but were, generally, spared and incorporated into current gardeners' management strategies. Although species composition was similar among home gardens in San Lucas, variability was represented by differences in the number of individuals per species found at garden sites. Numbers of individuals depended upon garden history (i.e., pre-established home gardens that had been reinhabited), the length of time women had been gardening in San Lucas and the employment of selected livelihood strategies. A correlation between the length of gardeners' residence, including concurrent gardening activities, and the number of species found in San Lucas home gardens was identified and pointed to increased diversity over time.

Analysis of study data also revealed that traditional environmental knowledge (TEK), passed down by women through generations and cross-generationally, did influence livelihood strategies selected by gardeners and, therefore, the economic welfare of HHs. TEK was found to be based on relationships between women with kinship ties. Established early in a girls life (aged three or four years), these relationships were characterized by the a progressive process of knowledge acquisition based on observations and experiential learning (hands-on inclusion in activities). Young girls began learning about aspects of TEK from older female family members, most commonly grandmothers, mothers and aunts, whom they assisted with daily tasks in the HH, home garden, milpa garden or milpa. Informal networks of women, based on close kinship ties, formed in this way and later expanded to include other female family members (i.e., cousins and mothers- sisters-in-law) as girls matured and established their own HHs, with adjacent home gardens and milpa gardens. When related gardeners met they discussed issues related to home gardening, forest extractive resources, milpa gardening (plantations), milpa production, family life, etc... Plant parts, such as seedlings, cuttings, seeds and whole fruits, were given as gifts, traded or purchased during gardener visits. The combination of discussion and exchange of plant parts functioned as a method of disseminating knowledge at both inter- and intra-community levels. This informal system of communication served women throughout their lives, despite geographic distances, and helps them to maintain kinship ties as well as to deal with production issues that may result from moving between environmentally diverse areas.

The only other type of women's group identified during the study was created at the request of GOB agencies as a mechanism for providing agricultural training to women in Kekchi and Mopan Maya villages located in Toledo District. The appointed Chairlady of the group was the wife of a village council member; therefore, membership was restricted by the social affiliations and kinship ties of this woman. The outcome of this type of artificial group formation was that some gardeners in San Lucas were not included in training opportunities because they were not related to, nor were they friends of the Chairlady.

Another interesting finding of this study was the inter-relatedness of female managed units of production. For example, women's livelihood strategies, emphasizing the production of food for family consumption, included not only home gardens but also milpa gardens and forested areas. Milpa gardens, or plantations as they were called by Kekchi gardeners, complemented home garden activities. Although there was some species overlap between home and milpa gardens, the species composition of milpa gardens was, in general, more diverse.

Both milpa gardens and forested areas provided gardeners with a range of tangible and intangible benefits including, but not limited to: low inputs (minimal/no clearing or burning, no watering, little weeding, no cash input), women were provided with opportunities to get away from the village when they visited both milpa gardens and forested areas, soil erosion was controlled by mulching in milpa gardens and by forest cover, economic species were protected from domestic animal predation in both areas and opportunities existed for women to collect and/or cultivate products that could be sold for cash (i.e., copal incense, spices and fruits).

The issue of land tenure recurred over the course of the research and proved to be closely related to women's ability to provide for HH needs. In fact, the existing system of communal land tenure was based on distribution to the male head of each HH (MHH). Women could only access land through their fathers, husbands or sons and were not allocated their own home or milpa garden, milpa or forested plots. The communal nature of land holdings, characterized by lack of legal title and *alcalde* (community mayor) approval for land distribution, perpetuated traditional methods of agricultural production and did not allow for the transference (i.e., sale) of land between individual farmers or families. This situation discouraged gardeners and their families from investing significant amounts of labour or other resources (i.e., money) in intensification activities, such as the cultivation of permanent crops. The impact of communal holdings on home garden production was demonstrated by the high number of woody perennials cultivated by gardeners. The time required for the growth, and potential for continuous harvests, of perennial species was an investment usually only made in home gardens where an informal type of ownership was recognized by the Kekchi. Home gardens/HH compounds, although still located on communal land, were sometimes disposed of differently than milpa and forested areas. For instance, large, diverse and highly productive home gardens, usually containing a high number of perennial species, could be sold for cash, rented or given away; otherwise, the site was generally abandoned if the occupants moved to another village. This differs from agricultural milpas and forested areas which reverted back to communal land, falling under the control of the *alcalde* and village council, if the farmer and his family left the village. In other words, farmers who had been allocated various types of plots gave up all future production rights to those areas when they left the village. It is understandable that farmers and gardeners would view investment in perennial species, on communal land, as a very big risk.

These results imply important relationships between resources, both physical and metaphysical, available to gardeners and members of HHs as they select specific combinations of livelihood strategies and derive the economic and environmental outcomes of these strategies. Development professionals and local extension personnel who are planning projects and programs with the potential to impact existing production practices, such as home gardening, need to be aware of the influential nature of these factors.

3.0 RECOMMENDATIONS

The results of this study lead to important policy and project/program development recommendations regarding the sustainability of land-use practices (un-ranked list):

1. Actively promote sustainability of production systems by recognizing and retaining existing management strategies (i.e. home gardens on the same piece of land, under consistent management for continuous outputs in combination) and developing, with the assistance of local producers, new strategies that will meet the dual goals of sustainability: production to meet human needs and conservation of ecosystem diversity.

In practical terms, existing home garden management strategies should incorporate permanent fenced sites. Not only would this eliminate the need to clear and burn a different area each year and construct a new fence, but the resources conserved by more efficient spatial utilization would provide gardeners with opportunities to diversity, or to increase production, by cultivating perennial species in areas previously cleared on an annual basis. Fencing would also hinder predation of plants by free-ranging domestic and wild animals. Further, mulching and/or the addition of organic matter to permanent fenced sites would inhibit weed growth and increase soil nutrient values, promoting improved growth and the potential of increased yields.

The sustainability of home gardens could be further enhanced by incorporating other management strategies designed to maintain or reduce inputs and maintain or increase output. In addition, other female managed units of production, such as milpa gardens (plantations), should be examined to determine if they complement or compete with home garden production activities and requirements. It is my opinion that milpa gardens are an integral part of female managed units of production in San Lucas. They are larger and more diverse than home gardens, they supply HHs with different types of production zones and outputs and they are located on previously cleared and cultivated land, providing an indirect benefit in the form of forest conservation. The combination of home and milpa gardens could provide a majority of HH subsistence needs as well as some cash crop income and the diversification required to be sustainable.

2. Existing pathways for dissemination of knowledge and methods of production should be acknowledged, studied to improve awareness and utilized by professionals and extension personnel when developing and implementing programs among Kekchi Maya gardeners. All women should have free access to program information, regardless of social affiliations or kinship ties, and the right to participate in workshops and demonstrations as they choose.

The structure of programs should adhere to cultural and community norms. For instance, women and girls in San Lucas do not generally interact with unrelated men, with the exception of student-teacher associations. Therefore, a female extension officer should be employed to conduct program activities among Kekchi women.

Since home gardens and milpa gardens are both agroforestry practices, the female extension officer could be sponsored by the Department of Forestry, the MOA and/or an independent source, to work jointly with these agencies in the development and delivery of programs. Shared programs would take advantage of available resources, while reporting and sharing of information would benefit all participating agencies, thereby reducing duplication of activities. Transportation must be provided for a female extension officer and acknowledgment that village overnight stays would be a regular requirement of the position.

The location of workshops and demonstrations is also important. These activities should be conducted in each community to ensure easy access for participants and to attract the most number of women. Field days are not an efficient method of providing instructing and sharing information because travel to a central location is not practical for women who have HH/family responsibilities. Further, a limited number of participants may attend a field day, whereas all women have an opportunity to participate in activities being conducted in their community.

Group structure should not be imposed upon gardeners by outside agencies or institutions. By this I mean that women should be free to come together and participate in activities conducted by development professionals and/or GOB extension personnel, regardless of social or kinship ties. A model for informal group establishment already exists among gardeners in San Lucas, functioning as a means of disseminating TEK. Although these groups are based on kinship ties, they include most of the women in San Lucas because everyone is connected by some level of kin relationship.

3. Inclusion of proposed program recipients in all stages of program/project planning, from problem identification through delivery of programs and testing of new technologies. Programs developed by geographically, socially, economically and culturally distant institutions and agencies lack women's intensive knowledge of their local environments, especially their strategies for coping with marginal land and limited resources. Reluctance of scientists and development professionals to incorporate women's knowledge into their conception of problems and subsequent policymaking

slows progress in solving problems of hunger (Sachs, 1996), environmental degradation and sustainability of land-use.

4. Develop land tenure/use policies, consisting of terms of accessibility and eligibility, recognition of diverse types of land-use as valid management practices and forge goal statements that incorporate management strategies emphasizing sustainability of the natural resource base.

Access to land for production of food is essential for women and HHs that are characterized as subsistence or semi-subsistence, such as those of the Kekchi Maya in San Lucas. Currently, women in San Lucas only have access to land through male members of their immediate family. This is important because landless rural women compose the poorest of the poor around the world and because of severe inequities in land ownership, numerous rural women live in HHs with limited or no access to land (Sachs, 1996; Dankelman and Davidson, 1988). In order to avoid this scenario there are a number of directions that could be taken in terms of land tenure policy development.

The current system of communal land tenure has certain advantages in that annual payments are minimal, access is available to HHs for production of crops and a variety of ecological conditions are available for allocation to HHs for production activities. Disadvantages include lack of access for women and little incentive to establish perennial species. However, legal title, or privatization, also has pros and cons. For example, purchase of land involves higher annual tax payments; limited access to a variety of ecosystems for production purposes; increased need for cash to make payments provides incentive to cultivate more cash crops, possibly resulting in a simultaneous decrease in subsistence crops, and the pattern of distribution may result in differential access of HHs to land (i.e., landlessness). What privatization does provide is the impetus for cultivating perennial species and investing more in land development. Leased land is very similar to ownership; however, it is even more vulnerable to changes in public policy because producers do not have legal title to the land.

If existing common property resources were to be privatized it could mean that women would be hungrier, more isolated, and less able to provide for their families. Increasing privatization clearly specifies individual ownership of land, often to men, and forces women to either lose access to land use rights or to renegotiate these rights in their HHs and communities, which usually alters their resource conservation strategies (Sachs, 1996). The development of any revised land tenure/use policy, applicable to communal land currently inhabited by the Kekchi Maya of San Lucas and beyond, should clearly provide access for women, should recognize variable production systems (i.e., non-traditional systems, agroforestry practices) and should seek to promote conservation, and hence sustainability, of the natural resource base.

The management strategies utilized by women in their home gardens and milpa gardens should be foremost on the policy agenda. The first and possibly one of the most significant factors to consider is the relationship between traditional environmental knowledge (TEK) and home garden diversity. Although the transmission of knowledge does not necessarily imply that a gardener will diversify or adopt new opportunities, it provides development professionals and local extension personnel with an opportunity to use a pre-existing method to learn about land management strategies and to disseminate scientifically developed agricultural and environmental methods and information to gardeners. This approach has the potential to increase the incidents of adoption of different production strategies and/or species among gardeners and their families.

4.0 SUGGESTIONS FOR FURTHER RESEARCH

The full potential of this study depends on similar studies being conducted in the future. By comparing the results of this study with future results, the impact of projects or programs on HH decision making and the role of women as home gardeners can be measured. For example, canonical data analysis could be utilized to compare the situation of San Lucas home gardeners/gardens from this research with data collected from future investigations. Further, data could be collected from other Kekchi and Mopan Maya home gardens in Toledo District and compared to determine kinship pathways by which knowledge is disseminated among female gardeners and how women's roles are changing vis-à-vis land tenure and amounts of land used for cash cropping verses subsistence production. Future research is especially important in areas that are more remote (i.e., do not have year round access to political and economic centres) where the inhabitants of Maya communities rely primarily on subsistence and semi-subsistence production and do not have the resources or the opportunity to participate in a formal, cash market economy.

Finally, any future research should be based on a larger sample size which would increase the power of statistical analysis and provide a more comprehensive 'picture' of forces that may be influencing home garden structure and function among Maya communities in southern Belize, Central America.

This study looked at Kekchi Maya women and their home gardening practices as a component of more expansive HH livelihood strategies. The aspiration was to reveal the factors that influence decision making as it pertains to management of the available natural resource base, specifically home gardens. Promoting options for HHs which are both economically attractive and ecologically sound could accomplish the goals of sustainable development by addressing the needs of the people and encouraging conservation of the natural resource base. This can be accomplished by incorporating the type of HH level information collected over the course of this study and promoting active participation of local people in determining their futures.

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APPENDICES

APPENDIX A

Land Use in San Lucas. 1995-1996. (all measurements given in hectares)[1]						
HH #[2]	Wet Season Maize Milpa	Dry Season Maize Milpa	Rice Milpa	Black Beans	Ground Foods[3]	Forest Resources[4]
G1	2.8	1.6	3.2	6	1.6	16
G2	1.6	*/*	1.6	4	1.2	6.4
G3	2.8	1.6	4.4	6.4	1.6	19.2
G4	2	0.4**	1.2	3.2	0.8	4.8
G5	1.6	**	6.4	9.6	1.6	10.4
G6	1.2	**	//	//	//	4.8
G7	1.6	**	//	//	//	13.6
G8	2	**	//	//	//	13.6
G9	1.6	0.4	//	//	//	8
G10	1.6	*/*	//	//	//	0
G11	2	**	1.6	2.4	0.8	8
G12	3.6	1.2	2.4	2.4	1.6	20
G13	1.6	**	1.6	3.6	1.2	0
G14	2.4	**	**	4	1.6	7.2
G15	2.4	0.4	//	2.4	1.2	11.2
16	2	**	**	2	0.8	8.8
17	1.6	//	//	1.6	//	0
18	**	**	**	**	**	0
19	2	**	1.2	2.4	0.8	0
20	//	//	//	//	//	0
Total	36.4	5.2	23.6	50	14.8	152
Avg	1.82	0.26	1.18	2.5	0.74	7.6

Total number of hectares used by San Lucas villagers	**282**
Average number of hectares used by each San Lucas HH	**14.1**

1 all estimates of plot size were given in manzanas by farmers during focus group discussions, informal interviews and field visits.
1 manzana = 0.8 hectares

2 numbers with a preceding "G" (1 through 15) refer to HHs participating in the home garden study.

3 ground foods refer to milpas planted with a high percentage of foods that grow underground (i.e., cassava, yam varieties, sweet potato). These milpas are intercropped with a wide variety of agricultural crops (see page XX).

4 those areas left under natural forest cover where utilization of forest products (i.e., incense, fruit, firewood, lumber) is permitted based on distinct areas assigned to each HH.

** represents farmers engaged in wage labour activities, either in San Lucas or another village/location.

// represents farmers who are farming cooperatively. Usually this indicates a group of brothers or an extended family group.

/ farmer has chosen not to plant a crop.

APPENDIX B

Home Garden Species Composition.

Scientific Name	Kekchi Name	Common Name	Garden Numbers G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15
Woody Perennial																	
Psidium guajava	pata	guava	4	2	9	7	2		1		1	9	11	2	2	2	2
Mangifera indica	mank	mango	7	2	7		1							3	1	1	
Annona squamosa	pac	custard apple	3		3	7	1				1						
Byrsonima crassifolia	chi'	craboo / nance	2	1	3	1						1					
Citrus aurantifolia	leem	sweet lime	2	1					1	1							
Citrus spp. (limon)	lamunx	lime	1		2		1										
Citrus sinensis	cheen	orange	5	4	12		2	1				6		2	1	1	
Coffea arabica	cape	coffee	2		1												
Theobroma cacao	kakaw	cacao		12	300									6	4		
Persea americana	o	avocado	1	2	1												
Musa (acuminata)	queney	banana						2								4	
Musa paradisiaca	tul	plantain				39		2					3			5	
Bixa orellana	xayau	annatto	4	1	1	1	1				1	1		2	1		
Carica papaya	papa	papaya - small														6	
Carica papaya	papa	papaya - large					3	1	1	1	3			9			2
Spondias purpurea	rum	golden plum/hogplum	5								2						
Syzygium malaccense ?		malay apple	1												1		
unidentified	che chay	che chay			5												
Cocos nucifera	coco	coconut palm	6	5	28	10	2	1	1		2	5			1		
Orbigyna cohune	mococh	cohune palm	3	8	10	17	4		6		8	6		14			1
Brosimum alicastrum		breadnut			1							1					
Crescentia cujete	jom	calabash			4						1						
Swietenia macrophylla		mahogany	5														
Shrub or Vine																	
Croton spp.		croton	7	2	11	6		1		2	3	4					
Hibiscus spp.		hibiscus			21			6	3	3	1	1					
Sanseviertia trifasclata	atz um	snake plant	x			x											
Gossypium hirsutum	nok	cotton		1	1						3	4	5			1	
Luffa cylindrica	mach palau	spanish towel					x	x		x	x				x		

Scientific Name	Kekchi Name	Common Name	Garden Numbers G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15
Crop or Herb																	
Saccaharum officinarum	utz'ajl	sugarcane	18			14					8						
Ananas comosus	ch'op	pineapple	9		8		5										
Citrullus lanatus	melon	watermelon	4	5			4		9								
Sesamum indicum	hong ho lin(?)	sesame/wangla	22														
Lagenaria siceraria	sel	gourd	2	6						2							
Cucurbita moschata	c'um	pumpkin/squash	2				1		2		2				5		
Sechium edule	chi'ma	chayote (cho cho)	3				3	2									
Lycopersicon esculentum	pixp	tomato	36		27	6	16	9	17					21			16
Brassica oleracea	repoi	cabbage	18		16	20		9	10					6			
Cucumis sativus	pepinu	cucumber			4								4				
Capsicum annuum		sweet pepper		11	9		12						9	7			
Capsicum frutescens	ic	chili pepper			3	9	2	1	2	4	5	7			3	7	3
Hibiscus esculentus	okr	okra			8												
Amaranthus (hybridus?) spp.	ses	callaloo			12								22	3			
Manihot esculenta	tz'in	cassava/manioc				4											
Colocasia esculenta	ox	cocoyam				7											
Cymbopogon citratus	iskij	lemon grass (clump)			3	2					2		1	2		2	
Eryngium foetidum	culantro	cilantro/culantro		x			x	x		x						x	x
unidentified	benq	(herb) ?			x												
Piper umbellatum	obel	bullhoof	8										4	6			
Ocimum basilicum	tep	basil			x												
Lonchocarpus castilloi	ch'alam	fish poison plant								1							

Garden numbers =	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15
Total species per garden =	27	16	29	16	18	13	11	9	16	11	8	13	10	10	6
Total number of individuals =	181	65	512	150	62	37	53	16	44	45	59	83	20	30	25
Indicates 'bunched' species = (unable to count individuals)	x	x	x	x	x	x		x	x				x	x	x

APPENDIX C

TRADITIONAL ENVIRONMENTAL KNOWLEDGE (TEK) QUESTIONS

TEK1: Focus group discussions and informal interviews.

TEK1 refers to the gardener exchanging, trading or giving/receiving environmental knowledge and/or plant materials to/from members of her extended family. In other words, the gardener maintains a give and take relationship with members of her extended family. Extended family members usually include men and women who are closely related to the gardener. For example: grandparents, parents, uncles and aunts, siblings and first or second cousins.

1. From who do you learn about collecting in the forest?
2. From who do you learn about growing and tending trees, crops and flowers around your house?
3. From who do you learn about working in the milpa/plantation?
4. From who do you learn about raising animals?

TEK2: Focus group discussions and informal interviews.

TEK2 refers to the gardener acquiring environmental knowledge (i.e., have been taught or told) from an older female family member(s). Older female family members include, but are not limited to: grandmothers, mothers, aunts and sisters. Environmental knowledge refers to anything having to do with natural resource management, with the exception of home gardens.

1. From who do you learn about collecting copal, nutmeg, allspice, etc. from the forest?
2. From who do you learn which leaves, trees, plants are good to eat, are used for wrapping food, are used to cure sickness, etc.?
3. From who do you learn about growing and harvesting plants in the plantation?
4. From who do you learn about preparing plants/animals to make crafts and utilitarian items(i.e., baskets, bowls, brooms, etc.) or for food?

TEK3: Focus group discussions and informal interviews.

TEK3 refers to the gardener acquiring home garden management knowledge (dissemination of information or have been taught) from an older female family member(s). Older female family members include, but are not limited to: mother, grandmothers, aunts and sisters.

1. From who do you learn when to plant, where to plant and how to care for and harvest plants around the house (i.e., construct seedbeds, when to harvest, etc.)?
2. From who do you learn what specific plants are used for (i.e., food, medicine, etc.)?
3. From who do you learn to prepare plants harvested from the home garden (i.e., calabash fruits, lemon grass, etc.)?
4. From who do you learn about what is wrong with (i.e., diseases) plants/animals in the home garden and what to do about it?

TEK4: Focus group discussions and informal interviews.

TEK4 refers to the gardener acquiring environmental knowledge (dissemination of information or have been taught) from other female family members. In general, other female family members would include more distant relations such as cousins and sisters- or mothers-in-law.

1. From who do you learn about collecting copal, nutmeg, allspice, etc., in the forest?
2. From who do you learn about preparing plants/animals to make crafts and utilitarian items(i.e., baskets, bowls, brooms, etc.) or for food?
3. From who do you learn which leaves, trees, plants are good to eat, are used for wrapping food, are used to cure sickness, etc.?
4. From who do you learn about what is wrong with (i.e., diseases) plants/animals in the home garden and what to do about it?

TEK5: Focus group discussions and informal interviews.

TEK5 refers to the gardener acquiring environmental knowledge (dissemination of information or have been taught) from a male family member(s). Male family members can include grandfathers, fathers, brothers, uncles, cousins, brothers-in-law, etc.. In general, it is usually those men who are most closely related to a woman (i.e., father, brother, uncle, grandfather) that interact with her the most.

1. From who do you learn about medicinal plants and what they are used for?
2. From who do you learn about building and repairing houses and storage sheds for maize or rice?
3. From who do you learn about preparing wild game?
4. From who do you learn about milpa farming (maize, rice or ground foods)?

APPENDIX D

LEGEND FOR HOME GARDEN DIAGRAMS

English Common Name	Symbol
guava	g, G
mango	m, M
custard apple	CA
craboo / nance	K
sweet lime	SL
lime	L
orange	o, O
coffee	F
cacao	
avocado	A
banana	B
plantain	Pl,
annatto	AT
papaya - small	p
papaya - large	P
golden plum/hogplum	gp, GP
malay apple	MA
che chay	CY
coconut palm	T
cohune palm	Z
breadnut	BN
calabash	CB
mahogany	Y
croton	
hibiscus	H
snake plant	
cotton	N
spanish towel	(n/a)

English Common Name	Symbol
sugarcane	I
pineapple	
watermelon	
sesame/wangla	
gourd	(seedbed)
pumpkin/squash	Q
chayote (cho cho)	(seedbed)
tomato	
cabbage	
cucumber	
sweet pepper	
chili pepper	
okra	
callaloo	
cassava/manioc	
cocoyam	
lemon grass (clump)	
cilantro/culantro	
benq (herb) ?	bunch
bullhoof	bunch
basil	bunch
fish poison plant	(n/a)

*Lower case letters indicate juvenile individuals.
*Upper case letters indicate mature individuals.
*n/a indicates species not in diagramed gardens.
*seedbed refers to the germination of plants in seedbeds under tables, inside houses.

Contents of Fenced Garden Areas

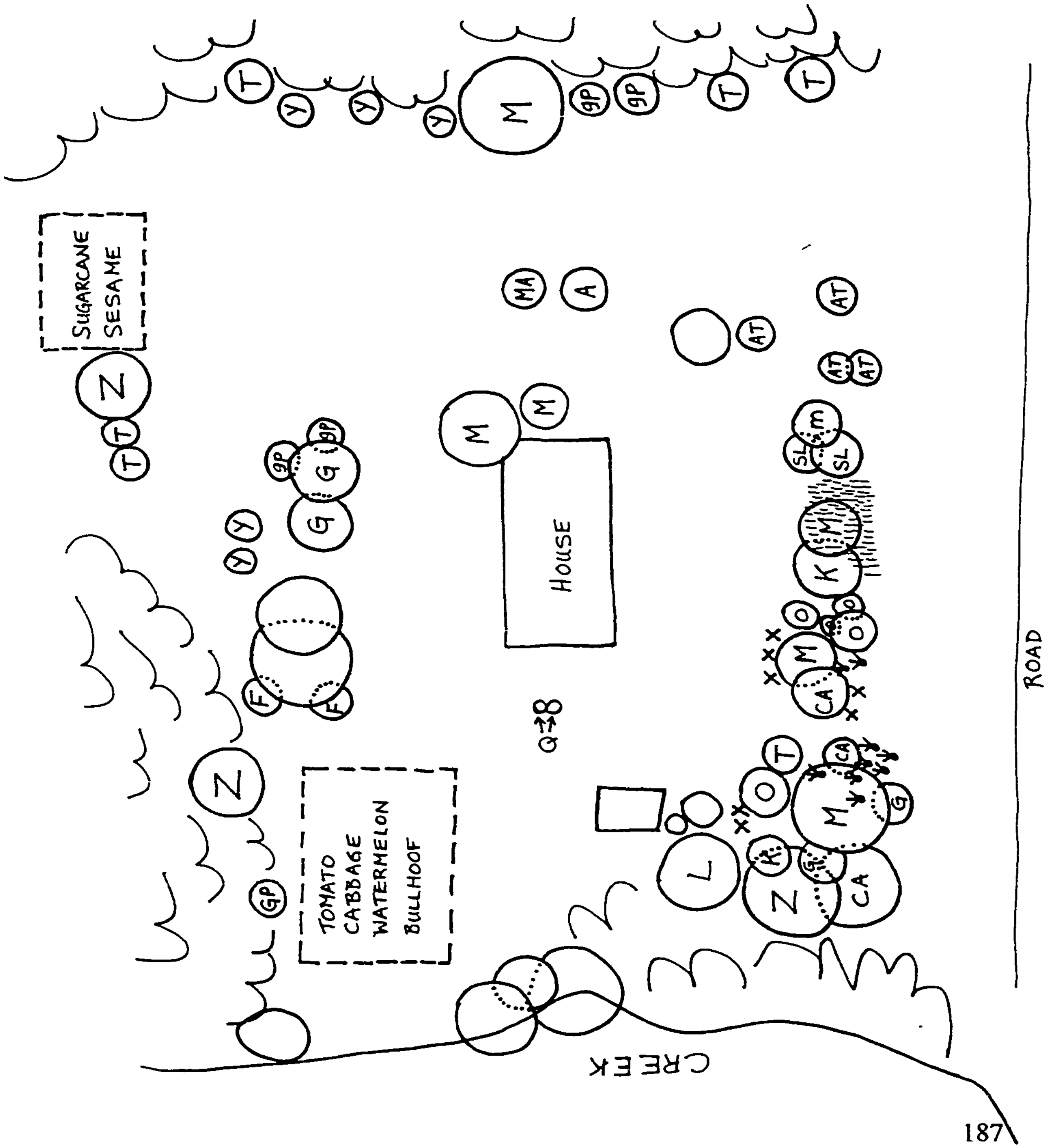
Garden G1	# of individuals
Sugarcane	18
Watermelon	4
Sesame	22
Tomato	36
Cabbage	18
Bullhoof	8

Garden G3	# of individuals
Tomato	28
Cabbage	16
Cucumber	4
Sweet Pepper	9
Chili Pepper	3
Okra	8
Callaloo	12
Benq (herb?)	clump
Basil	clump

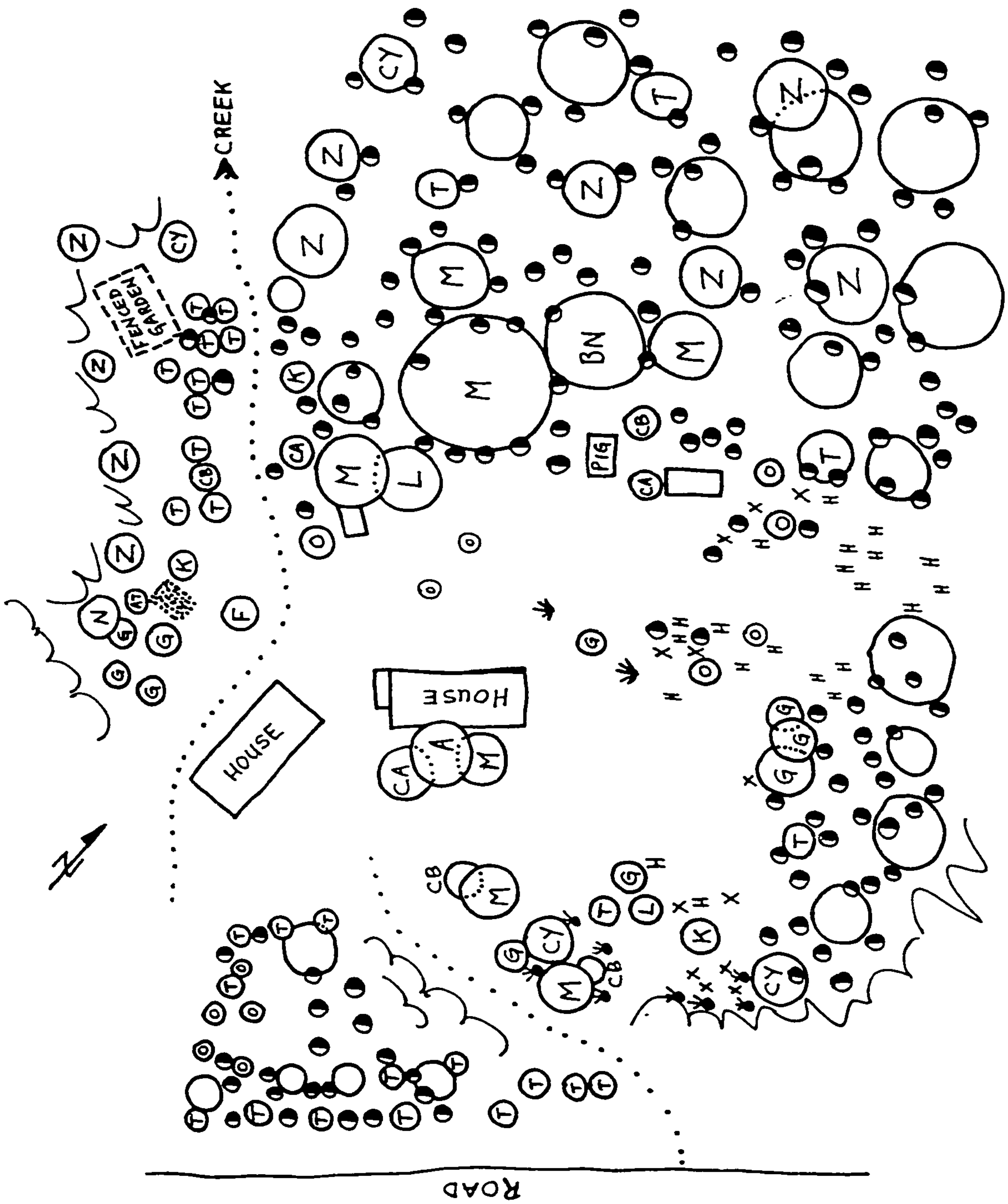
Garden G4	# of individuals
Tomato	6
Cabbage	24
Chili Pepper	9+

Garden G12	# of individuals
Papaya:large	9
Tomato	21
Cabbage	6
Sweet Pepper	7
Callaloo	3
Bullhoof	6

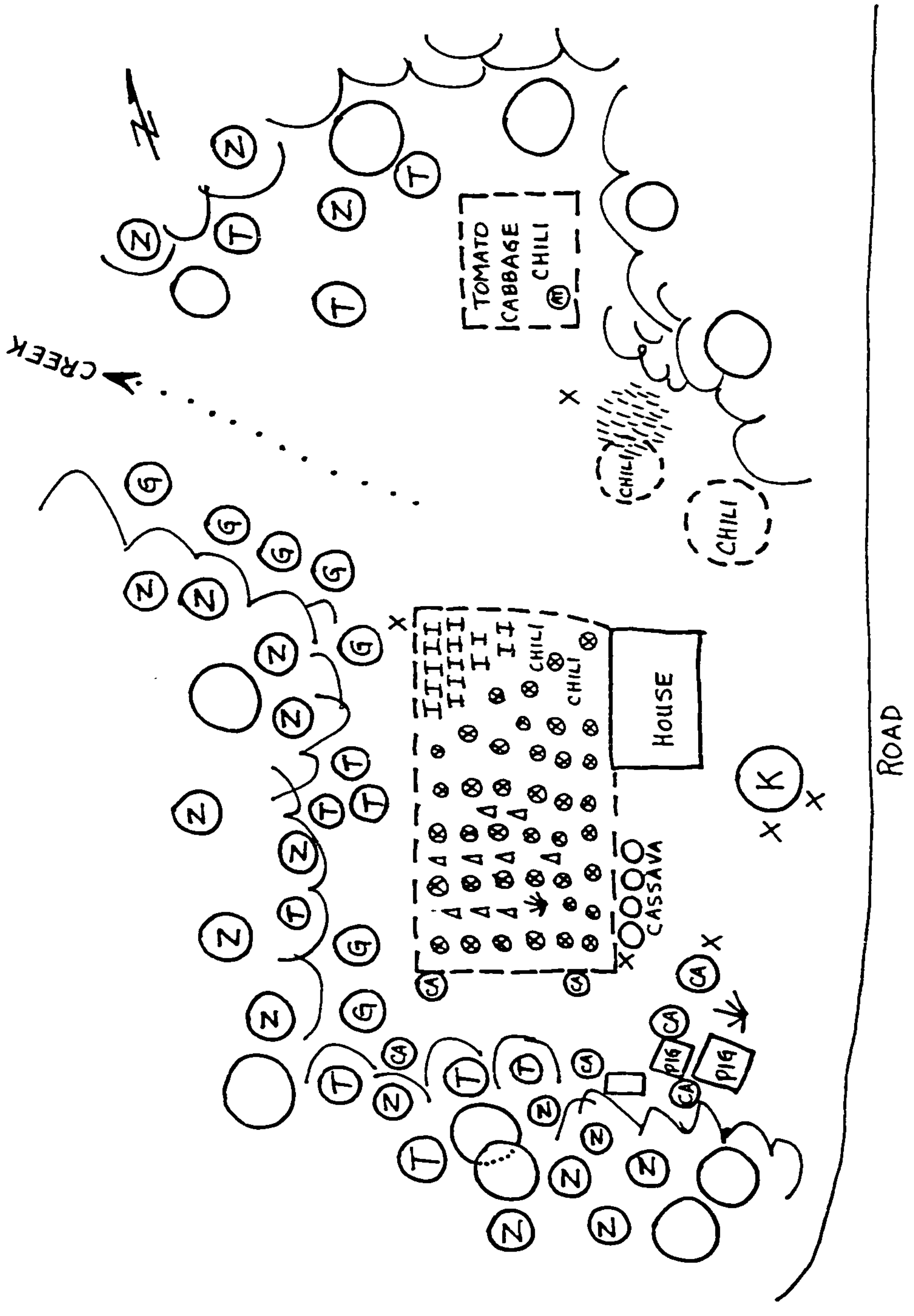
GARDEN G1


SUGARCANE
SESAME
HOUSE
TOMATO
CABBAGE
WATERMELON
BULLHOOF
ROAD
CREEK

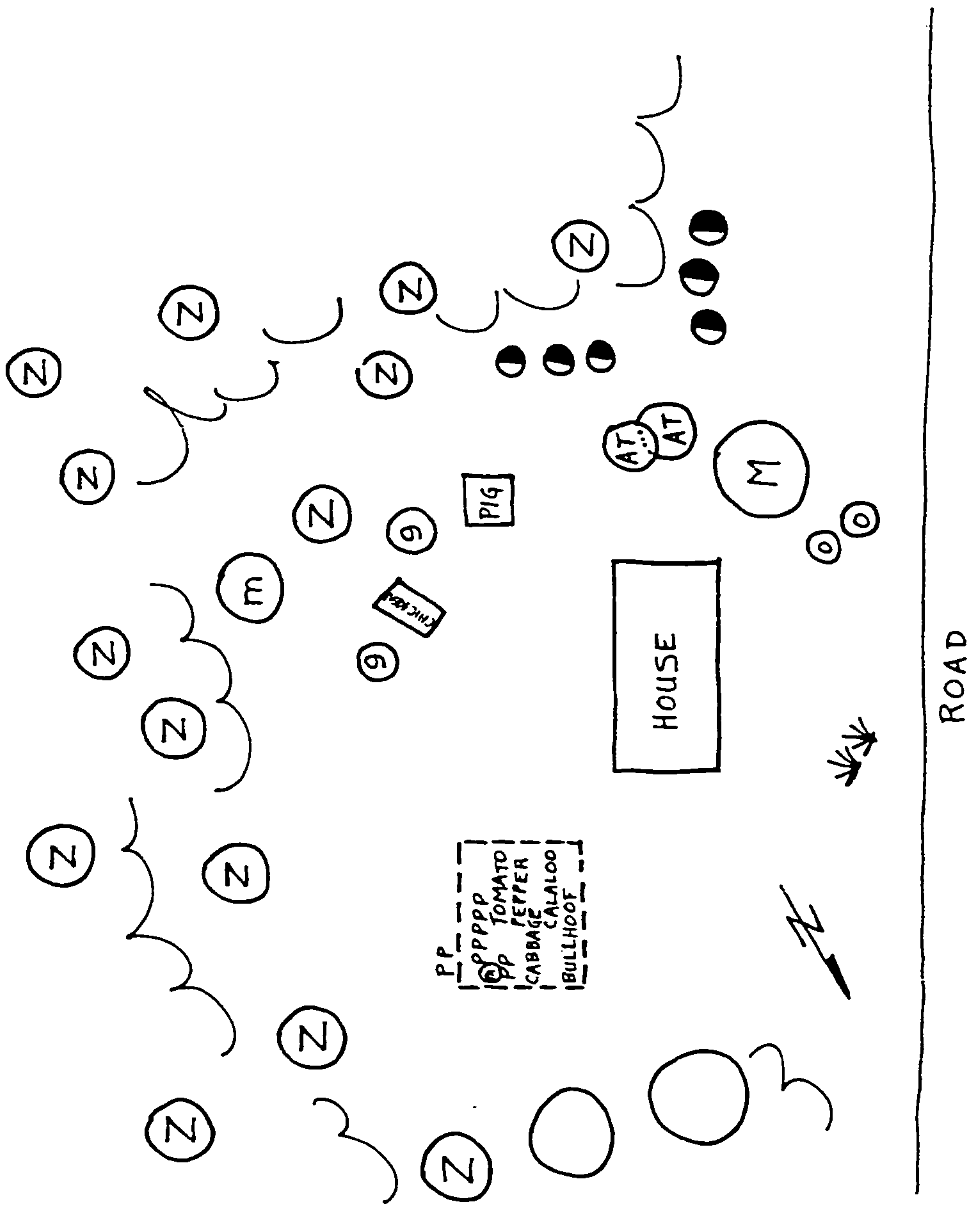
GARDEN G3



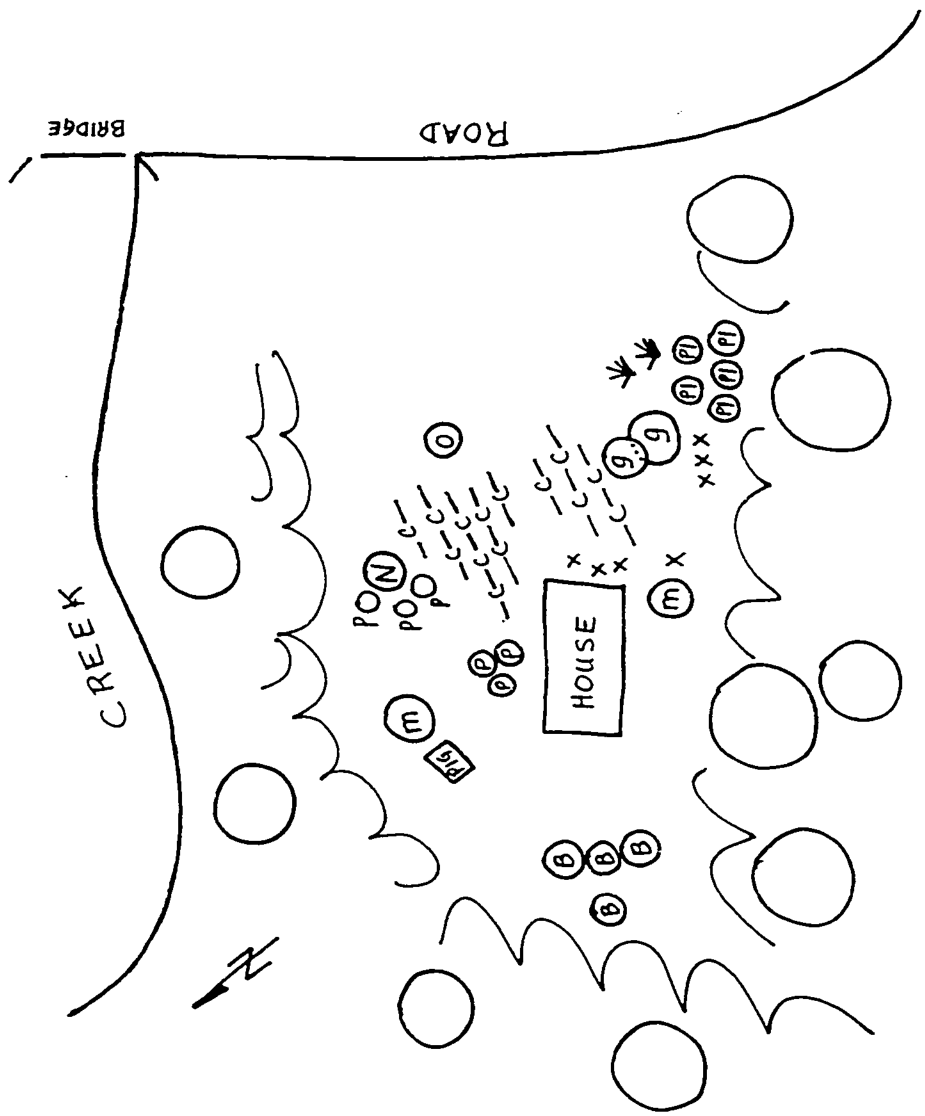
GARDEN G4


CREEK
TOMATO
CABBAGE
CHILI
CHILI
CHILI
HOUSE
CASSAVA
PIG
PIG
ROAD

GARDEN G12


ROAD
HOUSE
PIG
AT
AT
M
Z
TOMATO
PEPPER
CABBAGE
CALALOO
BULLHOOF

GARDEN G14



APPENDIX E

INTERVIEW SCHEDULE
BELIZE HOME GARDEN PROJECT
SAN LUCAS. 1995 - 1996

1. Name(s): ________________

2. Data for all family members and people living in your household (HH).

#	Name and Relationship	Gender	Age & Birthdate	Civil Status	Level of Education	Principal Occupation

Civil Status may be selected from the following:

1. civil marriage
2. religious marriage
3. both civil and religious marriage
4. common law
5. separated
6. divorced
7. widowed
8. single, never married
9. other (specify)

Level of Education may be signified using the highest grade level completed or the level completed (i.e., Standard 1 - 6, high school, college, etc).

3. Does your spouse or partner (circle one) live in this house with you? Y N

4. Total number of people living in your house _________

5. If you or your spouse/partner are employed outside the community, then:
   Where (region/town/village) ________________________
   How many days in each week or month ________________
   Seasonal employment / how long ____________________

6. What is your religion? (circle or underline)
   1. Catholic
   2. Evangelical
   3. Pentecostal
   4. Mormon
   5. no religion
   6. other ____________

7. Are your parents living? Y N
   If yes, where do they live? __________________________
   ____

8. What languages can people in you household speak?

Name	Language	On Farm	Off Farm	Other

RESIDENCE INFORMATION

9. How long have you lived in San Lucas?
   Whole life: Y N or # of years _______ months _______

10. If not whole life, then:
    Where did you live before you moved to San Lucas?
    (a) Name of community ___________________________
    (b) Location of previous community ________________________
    (c) Do you have family members who still live there? Y N
        (d) If yes, how many? ________
            (e) Relationship to you _________________________________
    (f) Why did you move? ____
    ____

LAND TENURE

11. In total, how much land does your family have/use in this community and / or in the region? (including agricultural, forest, orchard, etc..)
    __________ hectares / acres / manzanas (circle appropriate measure)

12. Type of land tenure:
    (a) reserve land __________ hectares / acres / manzanas
    (b) rented __________ hectares / acres / manzanas
    (c) owned by legal title __________ hectares / acres / manzanas

13. How long have you and/or your family:
    (a) occupied reserve land __________ years __________ months
    (b) rented the land __________ years __________ months
    (c) owned the land by legal title __________ years __________ months

14. Under whose name(s) is the land:
   (a) reserve land ___________________
   (b) rented ___________________
   (c) owned by legal title ___________________

15. Who has the right to sell, trade or give the land to another person? (give details)
   ____
   ____

16. In your family, or household, who decides when to buy, sell, trade or give land?
   ____

17. How much land is used for each of the following purposes?

Utilization of Land	# of hectares, acres, manzanas (specify measure)
Household compound	
Home garden	
Milpa (1st maize)	
Overgrown milpa	
Other agricultural use	
(insert other use here)	
Orchard (fruit trees)	
Tree farm (non-fruit trees)	
Forest (undeveloped land)	
(specifics of use here)	
Milpa: Beans (black/red kidney)	
Milpa garden	
Other (specify)	

Additional comments/observations: ___________________________________
____

HOUSEHOLD ACTIVITIES

18. Where do you obtain water for drinking? (circle ALL applicable)
   1. natural spring
   2. communal spring
   3. natural reservoir
   4. river/stream
   5. collect rainwater
   6. piped water (water service)
   7. other ________________

19. Where do you obtain water for cooking? ____________________

20. In general, where do you wash clothes?
    1. house 3. other ____________________
    2. river

21. How often do you wash clothes?
    1. once per week 4. daily
    2. two times per week 5. other____________________
    3. three times per week

22. Do you wash clothing for other people, or families? Y N
    If yes, how many times per week/ month? __________

23. If you walk to gain access to water, how far must you go?
    Dry season ______________ (# of minutes/hours or distance travelled)
    Wet season ______________ (# of minutes/hours or distance travelled)
    Equal in both seasons ______________ (# of minutes/hours or distance travelled)
    Source of water ____________________

HOME GARDEN

Home Garden Species and Harvest Times			
Common Name	Kekchi or Spanish Name	Number in Garden	Harvest (month[s])

Diagrams of home gardens are recorded in notebooks rather than in survey schedule.

24. Did you establish or begin cultivating the home garden that you now occupy?

Yes......When was it established? _____ year _____ month

No....... Do you know when the home garden was established and by whom?

_____ year _____ month

Name of person(s): ______________________________

What plants (species) were already there when you began gardening?

____

____

____

25. Have you ever received any instruction about the cultivation of a home garden?

Y N

If yes: year/organization/person teaching ______________________

____

26. Who is responsible for tending the home garden (planting, weeding, selecting species for inclusion in the garden, harvesting, etc.)?

1. you (FHH/gardener)
2. other ______________________________

____

____

____

27. Do you water the plants in your garden? Y N

If yes: how often? ______________________

who does the watering? ______________________

28. Who decides what to do with the money or goods received from the sale or trade of home garden produce? ______________________________

____

____

29. Indicate the uses and benefits that you obtain from your home garden.

Uses / Benefits Obtained from Home Garden	Response
Food produced for family consumption	
Food produced for exchange within the community	
Food produced for exchange outside the community	
Food produced for sale in the market	
Food and non-food items produced for fiestas	
Condiments:	
Medicinal plants:	
Gifts:	
Food for animals:	
Firewood:	
Construction Material:	
Organic fertilizer	
Soil conservation	
Shrubs for drying clothing and food, etc...	
Recreation area	
Shade:	
Other:	

Response may include: yes, no, maybe, don't know, etc...

30. What is the main use(s) of your garden? (choose all applicable)
   1. food / family consumption
   2. production for sale or trade (cash crop)
   3. other______________________________

31. What animals do you keep in your garden?

Animal	How Many	Use and Enclosure Type

Use: consumption/food, to sell, a pet, other.
Enclosure type: free range, penned, tied, other.

32. What food do the animals receive or obtain?

Type of Animal Food	Animal(s)
HH food scraps	
Agricultural scraps	
Purchased foods:	
Maize, tortilla, dough	
Coconuts	
Banana/Plantain	
Free-range / Forage	
Other:	

33. Who in the family is responsible for controlling/watching the animals that are kept in the garden around the house?

1. women
2. men
3. young women
4. young men
5. children boys / girls / both
6. entire family
7. other ____________________

34. Women's daily activities:

Women's Daily Activity Calendar	
	Percent of Time Daily
Cooking	
Childcare	
Gardening	
Laundry, Water Collection, Dishes	
Leisure Time:	
Other:	

Notes regarding daily activities: ____

____

APPENDIX F

HOME GARDENS vs. MILPA GARDENS: AN UN-RANKED LIST

During focus group discussions and visits to 'the bush' women indicated a variety of reasons for maintaining both home and milpa gardens, as follows:

Note: my emphasis or comments appear in brackets [ ].

- animals [domestic] around the house dig up and eat plants that aren't protected [by a fence or some sort of barrier].
- we don't have any space around our houses to plant some things [orientation of settlement to the roadside often limits the size of HH compounds].
- the land is not good [compact clay soils; too wet] for some plants, so we plant them in the milpa.
- the milpa is a better place for ground foods [soil is loose and better for development of root crops; domestic animals won't eat the plants].
- we like to go to the [milpa] plantation [one or two times each week groups of women (two or more), usually family groups, take food and go to their milpas for the day. Women spend the majority of their time in their houses and around the village; so they really enjoy going to the milpa to get away form the village].
- trees that bear a lot of fruit are planted and protected in home gardens because they need to be watched so that animals [domestic and non-domestic] don't eat the fruit.
- it's better to have fruit trees near the house so that we can get the fruit when it is ready.
- it's hard to clear a place and build a fence around it to keep the animals [domestic] from eating the vegetables [therefore, many plant species are cultivated in milpa gardens].
- it's easier to have vegetables and other things near the house when I have a new baby. [This woman also has two other children who are too young to accompany their mother to the milpa].
- it's good to have many different things near the house so that I don't have to go to 'the bush' [milpa/plantation] everyday.
- my children who are old enough to go to 'the bush' are now in school and I don't go to 'the bush' because my other child is too young.

APPENDIX G

List of Home Garden Species and Their Uses.

Scientific Name	Kekchi, Spanish or Creole Names	Common Name	Use
Woody Perennial			
Psidium guajava	pata'	guava	E:fruit/pod M:leaf (?)
Mangifera indica	mank	mango	E:fruit/pod S
Annona squamosa	pac	custard apple	E:fruit/pod, beverage
Byrsonima crassifolia	chi'	craboo	E:fruit/pod
Citrus aurantifolia	leem	sweet lime	E:fruit/pod, condiment
Citrus spp. (limon)	lamunx	lime	E:fruit/pod, condiment
Citrus sinensis	cheen	orange	E:fruit/pod, beverage CC
Coffea arabica	cape	coffee	E:seed roasted for beverage
Theobroma cacao	kakaw	cacao	E:fruit/pod, seed roasted for beverage CC
Persea americana	o	avocado	E:fruit/pod M:leaf (?)
Musa (acuminata)	queney	banana	E:fruit/pod
Musa paradisiaca	tul	plantain	E:fruit/pod CC
Bixa orellana	xayau	annatto/achiote	E:seed cooked for food colouring
Carica papaya	ch'onte/papa	papaya - small	E:fruit/pod
Carica papaya	papa	papaya - large	E:fruit/pod; leaf for tenderizing CC
Spondias purpurea	rum	golden plum/hogplum	E:fruit/pod
Syzygium malaccense (?)		malay apple	E:fruit/pod S
unidentified	che chay	?	
Cocos nucifera	coc/coco	coconut palm	E:fruit/pod, heart of palm S
Orbigyna cohune	mococh	cohune palm	E:fruit/pod, heart of palm U:leaf for thatch S
Brosimum alicastrum		breadnut (ramon)	E:fruit/pod S
Crescentia cujete	jom	calabash	U:pods as containers
Swietenia macrophylla	mahogany	mahogany	U:wood for carving, construction

E = edible M = medicinal U = utilitarian O = ornamental S = shade CC = cash crop

List of Home Garden Species and Their Uses.

Scientific Name	Kekchi, Spanish or Creole Names	Common Name	Use
Shrub or Vine			
Croton spp.		croton	O: whole plant
Hibiscus spp.		hibiscus	O: whole plant
Sanseviertia trifasclata	atz um	snake plant	M:for snake bites (?)
Gossypium hirsutum	nok'	cotton	M:applying medicine U:lamp wicks
Luffa cylindrica	mach palau	spanish towel/loofah	U:washing "sponge"
Crop or Herb			
Saccaharum officinarum	utz'ajl	sugarcane	E:"sap" used as sweetener, snack food
Ananas comosus	ch'op	pineapple	E:fruit/pod CC
Citrullus lanatus	melon	watermelon	E:fruit/pod CC
Sesamum indicum	hong ho lin(?)/wangla	sesame	E:seed
Lagenaria siceraria	sel	gourd	E:young fruit/pod
Cucurbita moschata	c'um	pumpkin/squash	E:fruiit/pod,seed,flower
Sechium edule	ch'ima/cho cho	chayote/cho cho	E:fruit/pod
Lycopersicon esculentum	pixp	native or hybrid tomato	E:fruit/pod CC
Brassica oleracea	repoi	cabbage	E:fruit/pod CC
Cucumis sativus	pepinu	cucumber	E:fruit/pod CC
Capsicum annuum		sweet pepper	E:fruit/pod, condiment CC
Capsicum frutescens	ic	hot pepper	E:fruit/pod, condiment
Hibiscus esculentus	okr/okra	okra	E:fruit/pod CC
Amaranthus (hybridus?) spp.	ses	callaloo	E:leaf
Manihot esculenta	tz'in	cassava/manioc	E:tuber
Colocasia esculenta	ox	cocoyam	E:tuber
Cymbopogon citratus	iskij	lemon grass	E:beverage M:infusion
Eryngium foetidum	culantro	cilantro	E:leaf for condiment CC
unidentified	benq	(herb) ?	E:leaf for condiment
Piper umbellatum	obel	bullhoof	E:leaf for condiment
Ocimum basilicum	tep	basil	E:leaf for condiment
Lonchocarpus castilloi	ch'alam	fish poison plant	U:seed for poisoning fish

E = edible M = medicinal U = utilitarian O = ornamental S = shade CC = cash crop