THE ROLE OF MEDICINAL PLANTS IN RURAL PARAGUAYAN LIVELIHOODS

By
NORMAN BREUER MORENO

A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

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For Bea

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THE ROLE OF MEDICINAL PLANTS IN RURAL PARAGUAYAN LIVELIHOODS

By

Norman Breuer Moreno

August 2000

Chairman: Peter E. Hildebrand
Major Department: Center for Latin American Studies

Changing global markets imposed new conditions on Paraguayan "campesinos" or small farmers when the price of cotton crashed in the late 1980s. Many had been effectively inserted into the market economy due to cash available from cotton sales during the 1970s and 80s. One of the strategies adopted to cope with these changes was a return to more traditional farming systems. Diversification, however, has been slow to come about, leaving many with no reliable source of alternate income. A complete return to a pure subsistence economy would be unreal because the cotton boom created a need for consumer items and a reversal of this trend is highly unlikely. Finding a substitute for cotton, as a cash provider, would ameliorate cash needs faced by resource-limited farmers. It is, however, unreasonable to think that any one crop will be able to provide the type of income and cash flow that cotton did in its heyday. The addition of several livelihood activities, tailored to individual regions and household compositions, then becomes a more real and attainable and sustainable solution to the problem.

Guiding questions in the research were whether the knowledge of the use, gathering, and cultivation of medicinal plants is a strategy for combining household security with market demands; what the effect of distance from the market is on growing a greater number of crops including medicinal plants; if households are better off if they combine market and non-market strategies; and finally, which household types at which locations are more likely to adopt the technology of cultivating medicinal plants as a cash crop.

The history of medicinal plant use is traced from pre-Colombian times to the present in an effort to place the demand for these botanical products in context. Medicinal plants are shown to be important for healthcare, nutrition, biodiversity conservation, human diversity, economic and community development, and cultural identity among other benefits.

Ethnographic Linear Programs (ELP) are models used to analyze complex small farms and livelihood systems. Resources and constraints are set in a matrix using a standard spreadsheet. Labor is disaggregated by gender, season, and age. The testing of different alternatives is possible because the model closely simulates a small family farm. This is achieved through the gathering of ethnographic farming systems data.

Results from the ELP included household types to target in medicinal plants production projects, the price at which medicinals replace cotton, the effect of remittances from family members on the system, and the effect of arable land used on the amount of medicinal plants grown and sold. Combining subsistence and market practices makes the farming system more feasible. Growing medicinals may benefit resource-limited farmers.

CHAPTER 1
EXPLANATION OF THE RESEARCH, QUESTIONS, AND OBJECTIVES

Prologue

Clemencia Escobar, a cheerful 51-year-old woman sat next to me as we drove to Ñu Pyahú. She was born there and had a happy and healthy childhood. When her father died, she was turned over to her godparents, as her mother had to cope with ten other children. I had known Clemencia for quite some time, but little did I suspect that she would play such a pivotal role in my fieldwork. Clemencia now lives in Asunción and is the single parent of two young adolescents, whom she tries to bring as often as possible on her yearly sojourns back to the hamlet of her youth, so that they do not lose contact with their roots. I asked Clemencia, as we drove past dry looking pastures thinly populated by scrawny looking zebu cattle, to describe Ñu Pyahú. She immediately fell into a long comparison of what it was like back then, and what it is like nowadays.

> *Before, people used to plant different maizes, like Tupí Pytá, and Chipá (red flint and yellow dent corn). There was alfalfa enough left over to feed the animals. Then people planted mostly cotton and very few food crops. They could not keep many animals. Nowadays, the animals don't even grow if you don't give them injections. Before, people had six or seven milking cows. Now they have just one or none at all. Before, people used to plant rice and separate the grain from the hull in a mortar. Now, rice and pasta are bought because no one plants rice any more. Before, life was easier. People were not in need. Everybody had 20-30 pigs, of which two or three were always fat. They gave meat and lard. Things that were common then are harder to find now such as manioc starch, 'typyratý' and 'fariña' (manioc starch). We used to make these things and it only took a half an hour to an hour. Before, people had 12 to14 children. Now they have only five or six. People don't work like they used to. If we got sick, someone would quickly concoct a*

remedy from backyard or forest plants, but we rarely got sick! Before, my niece Estella's father had 30 goats. Then, he ate the few that were left because recently people had been stealing them. He gave up. Before, those things never happened in the countryside, because nobody was in need. People became used to the easy life with cotton. Before the cotton, people used to make their own yarn and blankets from wool. Afterwards, people would end up losing or owing money with five or six hectares of cotton. In my time they would plant 'pety hu' (black tobacco) and twist it for sale. You would never walk into a person's house and find them without manioc or maize. You walked 20-30 minutes to make it to your 'chacra' (crop field). The youngsters used to plant to help the parents, and then they would go to the city or somewhere else to produce cash. Most chacras are now fallow and they require much more work for cleaning. Most wives work at the chacra. Few are able to stay at home. They plant and harvest, and do post-harvest cleaning. People work from before sunrise until 10:00 AM and then from 3:00 or 4:00 until dark (because the heat is unbearable). Before dawn they are already hoeing. People in the countryside are happier. You can stop working one whole week, and you still have something to eat... it is different in the city. If friends come that you want to be with in the country, you can leave the work in the field for two or three days, there is no problem. This is not possible in the city. Many people use pesticides, mostly on cotton. Before, you did not see as much leukemia disease. Now the 'Hospital de Clínicas' (Teaching Hospital of the Medical School in Asunción), is full of children with leukemia. People say that leukemia and 'púrpura' (hemorrhagic disease) may be from stockpiling cotton in the house where children play. Before everyone made their own 'yerba' (Paraguayan tea). Now they buy it. I don't even see people making 'petit grain'[1] any more. We used to eat rorá (corn bran), locro (hominy), mbeyú (manioc starch cakes), locrillo (cracked hominy cereal), borí borí (cornball soup), chipá guazú (corn soufflée), chipá ku á (creamed corn). Nowadays it's guiso (stew), tortilla (fried dough), and fried manioc with meat, often purchased jerky. (1999)

All this she related to me in good Spanish, a language she learned as a young adult in the capital, Asunción. Her bilingualism – so common in Paraguay – was going to permit me to grasp the shades and nuances of my interviews, many of which would be conducted in Guaraní, the native – and official language – of at least half the Paraguayan population. Clemencia's before and after pattern of storytelling reinforced in my mind the before and after of the cotton boom in Paraguay. While there are several

[1] An essential oil distilled from the leaves of the sour orange citrus and used in the perfume industry.

other factors responsible for the current situation in which rural people find themselves, one of the greatest to have affected them was the cotton boom, their dependence on cash, and subsequent loss of this valuable source of income.

Introduction

This thesis is about Paraguayan farmers, common folk whose culture and lifestyle deserve at least as much attention, study and preservation as the most remote forest tribe. In Sir Ghillean Prance's words:

> I believe ethnobotany includes the knowledge of local folk cultures as well as indigenous tribes. For example, I have learned a great deal from the caboclo of Amazonia who have taken up many indigenous beliefs and many plant uses. I hope that in our discussions we refer not only indigenous peoples, but include peasants, campesinos, caboclos, ribereños, mestizos or whatever they are called in different parts of the world. (1994)

It is about their insertion into the market economy and subsequent re-learning of old ways in order to adjust to the failure of cotton as a cash provider. It is about the many things that people do to adjust and survive. It describes one of the cultural characteristics that is most remarkable about Paraguayans of all ages and social conditions – the daily consumption of medicinal plants. These plants provide healthcare, nutrients, refreshment and savings on bus fare and visits to doctors. Much knowledge, contrary to the general assumption, is in the realm of ordinary country folk. There is of course, much to learn from remote tribes and their shamans in many parts of the world. However, medicinal plant knowledge in this work refers to that which is in the realm of small farmers – often mothers and grandmothers.

Increasing population density, along with the continued – and even increased – consumption of these plants, coupled with mass anthropogenic landscape alterations will lead to the extinction of certain species in the near future (Basualdo 1995, Lambert et al. 1997). By using a Farming Systems Research and Extension approach, I hope to identify families who can successfully raise medicinal plants as a cash crop. This activity could also help recover some of the plant species, which are in greatest danger of extinction. The loss of habitat and biodiversity are beyond the scope of this research and are a greater policy issue than can be addressed in this thesis. I wish only to offer a grain of sand in conservation at the species level, while at the same time suggesting a technology that may improve the livelihoods of certain households in rural Paraguay.

Chapter 1 will deal with the problem at hand, the research questions, objectives and the design of my research, as well as some of the characteristics of Farming Systems Research and Extension (FSR/E) and its value for this type of work. Paraguay, a little known and poorly understood country is described in some detail in Chapter 2, along with the study sites where I worked to gather information. Chapter 3 explores the links between medicinal plants, healthcare, development and conservation. The importance of these linkages in Paraguay is described in Chapter 4, as medicinal plant use is traced from pre-Columbian times to the present. A new concept – "the nutraceutical" – value of botanicals is brought out in this section. In Chapter 5, a linear program model of a Paraguayan farm is constructed in an attempt to identify recommendation domains for the cultivation of medicinal plants. The 6th Chapter shows several outputs from this mathematical model. Finally, Chapter 7 offers a summary, conclusions and recommendations.

The Problem

Small-scale farmers known as "campesinos" in Paraguay were drawn closer and closer to the consumer or market economy during the 20 years in which a system of solecropping of cotton was in place (1970-1990.) During this time, the relatively high and stable price of cotton allowed mills and middlemen to advance money to campesinos based on the amount of land they would be planting in cotton. Perhaps for the first time, consumer products were readily available to small-scale farmers. At first, items sold included the standard flashlights, radios and watches. These were followed by clothing, at exorbitant prices, furniture and finally, as subsistence crops were left more and more by the wayside – processed foods.

For generations campesino families had the benefit of a traditional diet consisting of manioc, corn, squash, beans, peanuts, coconuts and meat from chickens and pigs, sheep, goats, and beef. After the cotton economy, these same families found themselves buying canned meat, crackers from Argentina, canned sardines from Brazil, rice and noodles. Indeed, in many areas of the country, corn and bean based meals were sometimes totally replaced by a generic stew known as rice or noodle "guiso." Farmers found themselves needing cash to purchase more and more items at the market, and producing less and less food crops on their own land.

The transition to democracy in 1989 unfortunately coincided with the drastic decline of cotton prices. Some 250,000 campesino families found themselves in the position of having to relearn many forgotten subsistence crop practices.

Almost a decade later, many households are living at the interface between the consumer and market economies. Extremely aggressive advertisement campaigns for

soft drinks and clothing as well as tastes acquired during the cotton "boom" draw people toward the consumer side. A renewed awareness of the importance of food security, government campaigns for a return to diversified agriculture, and the simple lack of cash steer people back toward the perceived safety of the subsistence economy.

One of the factors, which may help keep campesinos from being further absorbed into the economy, is the traditional knowledge of the cultivation, collection and use of medicinal plants. Strikingly, nearly 80% of the population consumes medicinal plants on a daily basis (Moreno Azorero 1987, Favitski 1997). These botanical elements are used in treating a wide range of injuries and illnesses, thereby partially alleviating the need for cash to buy expensive manufactured pharmaceuticals. Analysis of this one aspect of a complex livelihood system may contribute to the understanding of peasant strategies for balancing food security and market demands, and also recognition of women's roles in this process.

Latin American research in conservation and development has tended to focus on the Amazon region, perhaps justifiably so, at least in light of worldwide pressure. New light could be shed on Paraguay from data generated by this study. One valuable aspect expected to emerge from this work is an increased awareness and interest for researchers regarding Paraguay, which could prove highly positive for a country in dire need of effective policies and programs on conservation and development.

Related Research

Medicinal plants are among the most misunderstood of all natural resources (Lambert et al., 1997). Since the recognition of their importance for healthcare and conservation in the late-1980s, much research has been done into this area of botanicals.

Information on the subject comes from several different, yet equally important and usually interrelated facets. The issue of medicinal plant policies and priorities has been addressed by Akerele (1991), de Alwis (1991), and Farnsworth (1991). The Food and Agriculture Organization (FAO) of the United Nations (UN) in its continuous series on non-wood forest products devoted an entire report to "Medicinal plants for forest conservation and healthcare." Balick, as well as many multilateral development agencies, national government ministries and NGOs, as reported in working papers, including those of The World Wide Fund for Nature (WWF), The International Union for the Conservation of Nature (IUCN) and Conservation International (CI) have grappled with the complex policy issues involved with the conservation of medicinals (Sheldon et al., 1996). Plotkin (1991), Shultes (1991), Balick (1994), Prance (1994), and others have explored the ethnobotanical and traditional knowledge of medicinal plants. Principe (1991), Anderson (1990), and Lynch (1995) explored valuation of non-timber forest products (NTFPs). This last author followed Lambert et al. (1997) of the World Bank in emphasizing the gender aspects of the medicinal plant realm.

One of the least researched and most urgently needed areas of study is the agronomy and ecology for the propagation of medicinal plants. Some work has been done in this area by Palvetich (1991), Heywood (1991), and government agencies of the People's Republic of China and India. More recently, publications have been produced at the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) including one by Montiel et al. (1998). Much of this last research mentioned is related to the INBIO[2] project between the Merck Corporation and the Costa Rican government. The specific

area of folkloric and scientific writings on Paraguayan medicinal plants is addressed in greater detail in Chapter 4 of this work.

Much recent research on Paraguayan peasantry has focused on "campesino" struggles, organization and search for land and power (Fogel 1989, Ocampos 1994, Palau 1998.) Other studies have focused on the cotton boom in Paraguay (Campos, 1986). On-farm trials and the structure of the Ministry of Agriculture of Paraguay was studied by Poey in 1986. He described its program objectives and attitudes of its personnel and how these reach small farmers. An annual country report by the World Bank in 1992 specifically raises doubts as to whether the traditional weakness of this public entity, that is, the Ministry of Agriculture, will be up to the task of influencing the course of events through technical or policy-based interventions.

Research Questions

This study was originally guided by four research questions. During the research and writing phases other questions and hypotheses arose. Many were explored and most remain unanswered. Therefore, efforts have been directed to the issues that the research was originally designed to answer. These were: 1) Is traditional knowledge of the cultivation, collection and use of medicinal plants a strategy for balancing food and health security, and market demands? 2) Are households better off if they combine market and non-market strategies because they can better maintain food and health security? 3) Is greater distance and/or less access to the market place associated with a greater diversity of crops grown, including medicinal plants used in lieu of commercial

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[2] INBIO: a private non-profit organization established in 1989 in Costa Rica. It established an agreement with the Merck Corporation in 1991. In it, Merck payed INBIO US$ 1 million for a laboratory and will share 50% of the royalties derived from any of the extracts of plant and insect specimens.

pharmaceutical products? 4) Can medicinal plants be grown as an alternative cash crop, and by what type of households, located where?

Objectives

The main objective of this thesis was to explore the feasibility of producing medicinal plants as a cash crop for certain resource-limited farm families. This refers to one of the many activities that may be undertaken by Paraguayan households to partially alleviate the need for cash that arose when the price of cotton became unattractive.

Secondary objectives included the gathering of as much current farming systems data as possible so that an accurate model could be used to predict the outcome of the introduction of this new technology. Extensive literature review demonstrating both the international importance of medicinal plants and the historical, cultural, and healthcare needs for these elements in Paraguay was undertaken with a specific objective in mind. That is, to demonstrate that cash income is just one of the many benefits to be obtained by cultivating this crop. An enormous amount of secondary good can be achieved because medicinal plants have such manifold positive characteristics. The material covered is expected to further aid and backup policy makers as they look for supporting materials for the implementation of medicinal plant cultivation projects in Paraguay.

Research Design

This study focused on two communities. The first was Aguaity, Eusebio Ayala, a community in which an important conservation, development and sustainable production program was undertaken between 1983 and 1993. These farmers were compared to farmers in a more remote region, Ñu Pyahú, in the Department of Caazapá. This is an older established "compañía" or outlying district of San Juan Nepomuceno. There were

no projects of community development or any other sort underway there at the time of my visit.

At Eusebio Ayala, a community-based organization had sought to improve the livelihoods of community members through agroforestry, sustainable agriculture and community projects during the late 1980s and early 1990s. This was called the Centro de Promoción de Campesinos de la Cordillera (CPCC), or Center for the Development of La Cordillera Small-Scale Farmers. This grassroots level undertaking received funding from the Inter-American Foundation, the German technical agency GTZ, and Helvetas until it ended in 1993 (Fretes et al., 1993).

Ñu Pyahú, on the other hand, has received no funding from international development agencies. It is a well-established, old community located in an area that may have been frontier 50 or more years ago, but which is now quite settled. It was chosen for several reasons. Among these were the facts that my facilitator and translator, Clemencia Escobar was a native of that hamlet. Its distance from Asunción (250 km) was also an important factor to be contrasted with the other site, which is much closer to the capital. This village had less access to the main market. The research took the form of surveys with open-ended questions. Households were chosen at random for drop-in visits.

The Farming System at Eusebio Ayala

"La Cordillera," where Eusebio Ayala is located, is one of the earliest colonized regions of Paraguay. Most soils are exhausted from up to 400 years of continuous use. This prolonged utilization, along with the hilly topography of the region explains in great measure the state of extreme deterioration of all natural resources today, which has been

compounded by several decades of the solecropping of cotton. Another contributing factor to the poor overall situation has been the fact that La Cordillera is and has always been a traditional provider of firewood, lumber and charcoal for the capital city of Asunción. This region is almost completely deforested, with only around 1.7% of the total area covered with native continuous forest in 1991. What little is left today is seriously deteriorated as is the brush and secondary growth woody vegetation that covers a large portion of the department (Fretes et al., 1993).

One of the unique features of this area is that, in some low-lying areas of grazing land, and in almost all farm plots, there is a medium to high population of the mbocayá palm (*Acrocomia totai*). It produces small round nuts (about the size of a ping pong ball) that are collected from the ground and sold to local industries where their pulp and kernel are pressed to make soap, cooking oil, and cattle feed. The demand for these nuts has been declining in recent years.

La Cordillera is blessed – as is most of the Eastern Region of Paraguay – with a great abundance of streams, rivers, springs etc., which are underutilized and poorly taken care of (if at all) at present. Irrigation is a very rare practice and with the exception of two or three very experimental farmers one can say that it is nonexistent.

Another characteristic of this region is its division into very small plots or "minifundios," a great number of which are less than one hectare in size, and have poor to very poor soil (Palau, 1998). This situation provoked massive migration away from the area either to new forested regions to the North and East, or to the ever increasing poverty belts around Asunción, and in many cases Buenos Aires, Argentina, where people have migrated in search of a better livelihood.

The population of La Cordillera department was 194,011 in 1982 and 206,097 in 1992 (official census data). Aguaity, a "compañía" where I worked has a population of around 600. The population has remained relatively stable due to the high rates of outmigration. In the population breakdown one can see that the great majority of the population is made up of the elderly, women and children, as young men of working age have mostly migrated elsewhere.

According to the 1992 Agrarian Census, there are 22,362 "fincas" or farms in La Cordillera (1981: 20,842), of which 60 % are less than five ha in size. The process of "minifundización" or the breaking up into smaller and smaller farms, has many contributing factors among which are the growth of larger ranching units, the expansion of suburban Asunción towards the farming areas for recreation or week-end farms, and population growth. There are also more complex background historical causes for this process, which are beyond the scope of this thesis to discuss.

On the positive side, the proximity of La Cordillera to the main consumer market of the country, Asunción, has turned it into one of the largest and most natural providers of food and produce to the capital. It is also, and has always been, the principal provider of building materials (bricks, roofing tiles, etc.) and firewood. This last item has led the Servicio Forestal Nacional (SFN) to calculate that more than 900 ha of forests are needed annually just to provide Asunción and the building materials industry with enough firewood yearly (Fretes et al., 1993). This represents a great advantage for this region if and when it can begin to produce firewood sustainably. Another advantage for the region is the fact of its proximity to the capital for providing fresh produce with a relatively low cost for trucking. Soils in La Cordillera Department are sandy or sandy loam oxisols

resulting from the decomposition of the hilly area's bedrock, which is sandstone. These sandy soils are the most common in the higher areas and on hillsides. The lower areas used almost exclusively as grazing, are silty sand to a depth of 25 cm, with an underlying stratum of black impermeable clay. It is this clay that is used as raw material for the many brick and tile factories in the area. Land that is devoted exclusively to agricultural use has suffered most since cultivation methods exclude trees and other cover vegetation leaving the soil bare and exposed to the elements for a period of several months a year. The common practice of burning stubble after the harvest compounds this situation.

A trend towards more perennial crops has been noticed in recent years, which allow better soil conservation, especially on slopes. This change in attitude has been heavily influenced by the CCCP, whose basic objective was to reintegrate trees onto the farm and avoid the total disappearance of what little natural forest remained. Several sites in La Cordillera Department were added to the project through the coordination of the CPCC, an organization that, aside from land use, was aiming at a holistic approach to improving the lives and livelihoods of small-scale farmers in the region. The project had different rates of success in different areas. Community, or rather communal projects, obtained the poorest results. The aspect of reforestation and diversification of crops, however, proved to be groundbreaking and an awakening to other small farmers on the all-important issue of erosion control through intelligent land utilization.

The Farming System at Ñu Pyahú

Ñu Pyahú, in the Caazapá Department, is a small hamlet of some 70 homes. It has a population of around 450 people. It is politically a "compañía" or outlying district of San Juan Nepomuceno. San Juan itself is a small town, yet large enough to provide a

limited market for the selling and purchase of goods. Its mean annual rainfall is around 200 mm higher than at La Cordillera, around 1500 mm. Soils are typical oxisols, and spodosols derived from sandstone. The valleys – as in Eusebio Ayala – are of a sedimentary silty sand layer in the A horizon with an underlying stratum of impermeable black clay at around 25 cm of depth. These are generally used for grazing.

Although there are quite a few young people, most of the ones interviewed during recent research for this thesis tended to be older. Literacy is fairly high and the local school runs up to the 9th grade. Agriculture and extractive activities – principally timber and "yerba mate" (*Ilex paraguariensis*) have been activities in this area for as long as anyone can remember. Timber nowadays is reserved for emergencies and on-farm use. Farm plots are much larger than the ones in La Cordillera. The original parcels were 18 ha each. Some owners still own farms of this size; others have divided it up to the next generation. However, few farmers managed to cultivate more than three ha in any particular season.

Technical assistance was more frequent in the past than it is today. The interviewees seemed in general very self-reliant and knowledgeable about their farming practices. With regard to the lack of agricultural extension mentioned above, Doña Erna Torres (aged 60) had this to say about extension:

> We got money from the bank when we were just married, and with just one harvest of ten ha of soybeans we began to do well. Back then an *Ingeniero* (agronomist) would come right out into the field to see how things were going. Now, there is only a técnico (practical technician), and he is not from the Ministry, he is private. Those who work at the bank now stay at their desks and don't want to come around here. They used to come on horseback! (1999)

Agricultural production in both areas involves a range of traditional crops along with some recently introduced ones. While Eusebio Ayala farmers tend to have more fruit trees, and less subsistence crops, those in Ñu Pyahú have more subsistence crops along with complementary agricultural and homemade crafts. These include elaboration of crude processed yerba mate, blanket weaving, and home-manufactured "eíra hú" (cane syrup), as well as "torcido," or chewing tobacco ropes and other activities. At both sites a few farmers had a general store in the front of the house. These were usually for self-consumption and to bring in some cash.

The selection of these two sites allowed me to operationalize the variable of distance from the market. Distance from the capital with its wide range of available institutions, including hospitals and schools and markets is the independent variable. The extent to which farmers in general and women in particular rely on medicinal plants as a first treatment for illness, and the diversity of the kinds and uses of these plants, as well as the variety of food crops, are dependent variables. Household compositions were variable at both sites, as they are anywhere. Household composition as a variable to be tested as a factor affecting the likelihood of adoption of the cultivation of medicinal plants was studied at both sites.

Paraguay

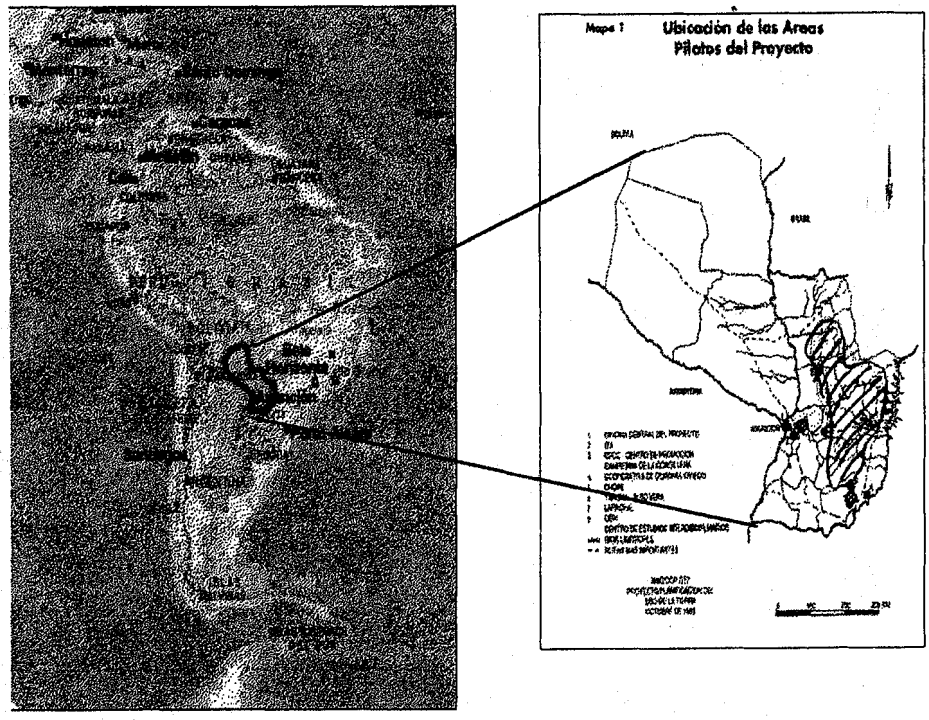

Figure 1. Map of Paraguay Showing the Research Sites

Methods and Analysis

Theoretical Methodology

Farming Systems Research for Development and Natural Resource Management

Farming Systems Research and Extension (FSRE) is a multidisciplinary approach to understanding and attempting to solve the problems of resource-limited farmers. The main idea being that the research and solution of problems comes from farmers themselves. They participate actively in every step of the process. This approach grew out of the realization that the Green Revolution was not reaching everyone. With its emphasis on High Yielding Varieties (HYV), costly inputs and ideal conditions at research stations, wealthier farmers were being made richer and the poorer were being left by the wayside (Conway, 1998). As one way of dealing with this, FSRE was developed on the late 1970s and early 1980s, with methods that focused on the needs of the small-scale farmers and developed research and extension methods that responded to the social and environmental and especially the great diversity within small farming communities.

A key to this process is the formation of multidisciplinary teams to conduct surveys or "Sondeos" (Hildebrand, 1986). These are rapid surveys that prove extremely useful when time and money are limiting factors for researchers. On-farm visits are conducted with the farmers to understand their farming systems. The objective is not to isolate and analyze each individual part, but rather to understand how the system works.

This system is particular to each region, indeed to each household or farm. A small-scale farm is a household first, then a business (Hildebrand, 1986). With the farmer's help, on-farm trials are designed to search for specific solutions for that particular site. The final objective is increasing the farmers' productivity and thus, well being. Often, this is achieved through a new technology, usually site specific and with great potential for diffusion and adoption.

Modeling farm systems obligates the researcher to go out into the field and gather ethnographic as well as production data *in situ*. The model is later formulated, and in order to validate it, he or she may go back to the field and try it out on those same farmers. By honing and fine-tuning the model, one can come to a very approximate simulation of reality. This accuracy allows us to predict the result of new technologies on farming systems.

Too often general life zones, typical family, average farm, and large areas are covered by a program without taking into account the great human diversity present in any given area. It is often argued that the models are not valid because they fail to take into account macro-economic effects. Their relevance for this thesis, however, resides in their use as a tool to help answer the questions that guided the research. Whether campesinos are better or worse off than city folk remains largely subjective and cannot be answered by a model. Nevertheless, constraints, resources (especially food availability), can tell us a great deal about why so often peasants say they are better off than urban people. There is an apparent greater flexibility to survive in spite of externalities and the political-economical macro context of any given moment. This does not mean that the macroeconomic context, markets, credit, transportation, and healthcare do not affect the

resource-limited farmer. Nor should the study of their systems and at the farmgate. It merely refers to a position that may be considered powerful in some ways. In the words of González de Olarte: "Compared with the urban population and rural wage laborers, the peasantry as a whole seems better able to neutralize the effects of an unfavorable macroeconomic context (1992)."

An ethnographic linear program[3] was constructed in Chapter 5 of this thesis. The model used data collected through personal interviews conducted at both sites during July and August, 1999. The objective of this model was to simulate a real farm, within the macroeconomic context, and thus permit the identification of recommendation domains for the cultivation of medicinal plants. This novel activity may help certain types of small-scale farmers diversify their production, and thus their cash income, without compromising household food security.

Fieldwork Methodology

Interviews: The work began by randomly sampling households expected to have a variety of family compositions. At least ten families were interviewed between both sites (five at each), to obtain information on farming systems. Another 45 families were surveyed at each of the two sites seeking data on medicinal plant use.

The principal male and/or female member of each family was surveyed using questionnaires (whenever possible) with specific questions about who cares for the home garden and the "chacra" or field. Additional questions included data on how many hours each activity requires, how plants are used when illness strikes, how often they are used, how they are used in combination with purchased-drugs, along with questions about time

[3] ELP: A mathematical model simulating a complex small farm based on data obtained through ethnographic research.

allocation. Tables recorded crops raised, time spent on field activities and the flow of cash. Nearly 100% of the interviews were conducted in the Guaraní language (except for a few at Eusebio Ayala, where some farmers were comfortable with Spanish). Having a mixed gender team, which was perceived as more serious and less intimidating, facilitated rapport with women. I presented myself as a student. My personal background (Paraguayan) and knowledge of the language (basic Guaraní) and customs allowed me to reach a sufficient degree of familiarity with the farmers within a relatively short period.

An attempt was made to identify non-users of medicinal plants at these same sites, their answers to a separate set of questions were undertaken in search of a control group. Only one person out of 45 interviewed did not "usually" take medicinal plant infusions.

Analysis

The results of the fieldwork were analyzed in two manners: qualitatively and quantitatively. In the qualitative analysis, community members of different ages, sex, and social standing reported people's roles as producers and collectors of medicinal plants through narratives. These data focused on identifying the illnesses which occur most frequently in the household, including injuries and the "first-aid" response to these afflictions. The role of the "médico ñaná," or traditional herbal healer was not explored, except for the fact of how much he charged and how often he was visited. The objective was to find out about household healthcare.

Quantitatively, at least six households were analyzed using linear programming as it applies to economic analysis of small farms and livelihoods systems. This process consists of two phases. The descriptive phase in which the farm is described and that

description is validated. This is followed by an analytical phase in which a number of different tests can be run using the model for prediction purposes. In this manner, several families in different stages of their life cycles, at both sites, were studied in search of diversity rather than attempting to identify a "typical" household (Hildebrand, 1986). The main activities and constraints were identified and quantified during family interviews. A model was created in which men's and women's contributions to the family economy are disaggregated and quantified, especially with regard to the home medicinal plant garden and its use. Household (or livelihood) Security is defined as being able to produce or obtain enough food to feed the household, and to produce or gather the plants necessary for primary healthcare. This is an important household objective in areas where there is no health facility nearby, nor speedy modes of transportation (ambulances) for reaching better equipped health centers located more distantly.

In order to construct the ethnographic linear program model, farmers were asked questions about food sources, medicinal plant sources, cash production and handling, and constraints on land, labor, cash, and infrastructure. In order to analyze one particular aspect of a system, in this case the medicinal plant home garden, the entire system, and its variability must be understood (Hildebrand, 1986). This type of study complements broad economic feasibility studies that are usually undertaken by multilateral agencies before implementing projects.

Significance

This study will contribute to the understanding of "household" (food and health) or livelihood security issues, by gathering data through surveys and interviews. These will be used to build a linear program that simulates small complex farms and can be

used for prediction purposes. The role of medicinal plant home gardens, and women's roles as well as conservation at the species level will also be explored. It will also generate information on the post-project status of farmers at the CPCC site and the current status of farmers at the Ñu Pyahú site.

In the following chapter, I will give an overview of Paraguay in general taking into account that it is a little known country. Socioeconomic and political conditions will be recounted in an effort to keep externalities and the macroeconomic picture in the back of our minds while describing the before and after of farmers with relation to the cotton boom. While this latter phenomenon was certainly the series of events that affected them most directly, many other things were going on in the country at the time over which they had no control at all, but which also affected them.

CHAPTER 2
CONDITIONS IN PARAGUAY AND AT THE STUDY SITES

Socioeconomic Conditions in Paraguay

Paraguay is a landlocked country in the heart of South America, with an area of 406,752 sq. km. It is bisected North-South by the Tropic of Capricorn, and has a continental sub-topical and tropical humid climate. Two great rivers drain the country: the Paraguay and the Paraná. The Paraguay River divides the country into two very different regions. The Occidental or Chaco region, comprising 62% of the land-mass, a relatively dry thinly populated area, and the Oriental or Eastern region, comprising 38% of the country's land, which is much more populated as well as more adequate for farming. On the Paraná River, two large hydroelectric dams[1] - one shared with Brazil and another with Argentina - provide the country with a great availability of electrical energy. Unfortunately, the distribution grids are not up to par with the dams, and electricity does not yet reach all Paraguayans and is expensive for those who have the benefit of its use. The massive amount of money brought into the country during the construction of these dams - two to three billion dollars by some estimates - forever changed the bucolic leisurely paced lifestyle of Paraguay. The construction of the Itaipú dam occupied a huge labor force. Most of these workers had migrated toward the construction site from farming areas. Completion of the dam and the subsequent release of its workers coincided with a drastic reduction in the price of cotton (Palau, 1998).

[1] Itaipú, with Brazil, and Yacyretá, with Argentina, both on the Paraná River.

According to the 1992 census, the population of Paraguay was 4,152,588. The current population is estimated to be 5,050,000. The population growth rate of 3.2% is the highest in South America. If this trend continues, the population will double in 22 years. The spatial distribution of the population is 50.3% urban and 49.7% in rural areas. According to this tendency, by the year 2010, Paraguay will be an urban country. Nevertheless, the rural population will grow by 570,000 persons or 100,000 families. With 37% actively engaged in agriculture, rural Paraguay will continue to be important and strategic in any process of economic growth (Palau, 1998). As in many developing nations, there is a great preponderance of young people with 67% being under 30 years of age and 41% being less than 15 years old.

The landlocked geographic location of the country imposes some difficult conditions as it isolates the country from the great economic and cultural trends current in the principal developed centers of the world. This obstacle has continuously checked development since it is a severe limitation of opportunity for participation in international affairs, especially trade. However, isolation has been a major factor in the continued and widespread use of medicinal plants from pre-Columbian times to the present (Basualdo, 1995).

In addition to the disparate structure of land tenure – 77% of land is in large holdings in the hands of just three percent of the population – Paraguay lacks valuable mineral resources, resulting in an economy that depends fundamentally upon agriculture and cattle raising. The country's predominant structure of agriculture and cattle raising has contributed to a limited industrial development. Other causes of this underdevelopment are the lack of mineral resources mentioned above, a limited market

and competition from its industrial powerhouse neighbors – Brazil and Argentina. The relatively limited manufacturing sector is unable to absorb labor, which is fundamentally unskilled and continuously growing due to the migratory phenomenon from rural areas to the cities (Palau, 1998).

Agricultural expansion occurred in conjunction with the building of the Itaipú dam and the much criticized agrarian reform by which the government distributed land to thousands of peasant families. This increment in agricultural production resulted in amazing growth during the 1970s of approximately 10% per annum. This surge slacked for several reasons in the mid 80s: first of all, at the conclusion of the construction of the Itaipú dam. Thousands of workers were left without jobs, as new building projects were unable to absorb the new abundance of semi-skilled labor. Second, the agrarian reform was derailed as a result of the economic difficulties of the 80s. To this date, the State does not have public lands needed for settlements. Almost all land apt for agriculture is in private hands, and the little land the State does possess is mostly marginal and suited for cattle raising. This exhausted availability of public lands and, above all, the February 3, 1989 politico-military coup, which dismantled the repressive structure of the previous regime, stimulated a process of spontaneous occupations of private property, generating movements of "landless" peasants. The government that was pressured on the one hand by large business interests, both national and foreign, to protect private property, and on the other hand by small farmers who are increasingly organized to claim their rights, has come to a stalemate on land reform claming that resources are unavailable for continuing the program (World Bank, 1992).

An unfortunate policy established that unproductive "latifundios" or large estates would be subject to agrarian reform. This piece of legislation, although funded on the high ideals of the social function of land, proved disastrous for the environment and the economy. Almost all land occupations occurred – and indeed are still occurring – on privately owned forestland. Many owners – principally cattle ranchers – sought to change the status of their land from unproductive "latifundios" to productive lands by clearing and burning forests and converting them to artificial pastures. The combined result of this situation along with the natural expansion of agriculture caused a massive and progressive deforestation. According to the Food and Agriculture Organization of the United Nations, Paraguay's eastern region has only 3% of the primary forest area it had in 1950 (FAO, 1997). Illegal logging for the Brazilian market has contributed heavily to this ecological catastrophe.

Another phenomenon that came with the expansion of agriculture in the 1970s and 80s was the introduction of mechanized crops, such as soybeans, wheat, maize and sorghum. These crops, along with the small-scale cultivation of cotton, are the pillars of the Paraguayan economy. Eighty percent of production is exported. The terms of trade however, have not been favorable during the last decade, as the two principal export items – cotton and soybeans – underwent a decrease in real export value of around 45% (Central Bank of Paraguay Report, 1997).

Table 1. Paraguay Macroeconomic Data 1990-1995

Indicator	1990	1991	1992	1993	1994	1995
GNP*	3.1	2.5	1.8	4.1	3.1	4.2
Inflation**	44.0	12.0	18.0	20.4	18.3	18.0
Exports*	1.3	1.3	1.2	1.1	1.8	1.1
Imports*	1.4	1.7	1.7	1.5	2.8	2.5
Balance of trade*	-0.1	-0.4	-0.5	-0.4	-1.0	-1.4
Foreign Debt*	1.7	1.8	1.2	1.2	1.4	1.3

* Billions of dollars
** Percentage

Source: Palau, 1998

There are some 250,000 families of small farmers. Considering the average family size of six, 1.5 million people make their living directly from small-scale farming. The proportion of land cultivated among "minifundiarios" or small farming units is nearly 70%. Units from 20 to 100 ha cultivate 42% of their land and those 100 ha or more in size use an average of 12% of their land.

Land tenure is an issue in Paraguay as in other parts of the developing world. Many small-scale farmers lack formal title to land, denying them access to credit. However, between 1992 and 1993, the Institute of Rural Welfare granted almost 10,000 property titles (Gutiérrez, 1995). Unfortunately, it is all too easy to obtain land in a new settlement and then sell the "rights" to newer settlers when the lack of hardwood species

makes it more viable to move on to a new plot. This pattern was begun in Eastern Paraguay by Brazilian immigrants (Palau, 1998). Productivity of land and labor is very low and, as a consequence, profits are limited generating dissatisfaction, which leads to great social pressure (Gutiérrez, 1998). The need to provide peasants with social services, which are high in cost and quantity, constrains efforts for land reform.

The deficient spatial structure of the production units as far as not being able to satisfy the growing populations' needs for education, health and better dwellings is a causal factor in the migration phenomenon from rural to urban areas. This tendency may be irreversible and progressive over time. Neither the economy or city infrastructure is properly prepared to deal with this. Conditions no longer exist to "export" poverty (Palau, 1998).

The distribution of the active population per economic sector is 51.7% primary (agriculture, forestry, fishing, and mining) in 1972, but only 35.0% in 1992. The secondary sector (industry) has remained relatively unchanged, at 18.7% in 1972 and 19.7% in 1992. The service sector grew from 29.6% in 1972 to 40% in 1992.

Table 2. Poverty in Paraguay in 1992 (in number of inhabitants)

Characteristics	Metropolitan area	Rural area
Indigence	26,000	657,000
Basic poverty	156,300	588,000
Total poverty	182,300	1,245,600
Total 1992* Population	1,224,579	2,253,116
% of poor	15	55

* The 1992 estimated population was 5.05 million. It is not known if absolute poverty has augmented proportionally. Source: Palau, 1998

Average years of schooling for the population is 4.9 years: 6.2 in urban areas and 3.5 in rural areas. The situation of women peasants is particularly critical, as they average only 3.4 years of schooling. Another breakdown shows that 65.4% of the population has a primary school education, 22% a high school education and a mere 3.4% reach the university level.

The rate of school retention, according to the last period considered (1988-1993) is only 54%. Of 157,000 children enrolled, only about half finish primary school in urban areas and 41% in rural areas. It is evident that there is a marked difference between the educational opportunities in the capital and other cities and rural areas, as well as in the quality of education (Ocampos, 1994).

While average life expectancy is 67.2 years (World Bank 1992, WHO 2000), the infant mortality rate is above average for the region. The major causes for mortality, especially in children are pneumonia, anemia and diarrhea. The lack of potable water, which reaches only 31.5% of homes and the lack of modern sewage systems, which reach only 7.7% of homes, contributes to generate these results.

Health services are severely limited in rural areas. Problems include: a lack of adequate health centers, in number and in quality, concentration of medical personnel in the capital and principal urban centers of the country, leaving rural areas deserted, the high cost of drugs, and the high cost of medical personnel. One of the most significant causes of the infant mortality rate is that 60% of births occur without medical or paramedic assistance and away from assistance centers.

There is a need for nutritional education, which could induce improved agricultural practices, through which the small-scale farmer and his/her family could eat

more nutritiously. The role of medicinal plant consumption as providers of vitamins and minerals is becoming more evident as they are viewed in a new light as nutraceuticals[5] (Ferreira, pers. comm., 1999). Health education would allow the adoption of preventive means to reduce work-related injuries, especially intoxication with pesticides. Environmental education could lead to the implementation of conservationist practices, leading to improve general welfare. In turn, better-protected habitats, coupled with studies on sustainable extraction levels, could provide a permanent source of medicinal plants for all Paraguayans.

An aspect worthy of noting at the household level is that due to wars in the past and political upheaval, women have often assumed the role of heads of families. This was true of 21.8% of homes included in the 1992 census. Furthermore, 40.26% of women aged 10 or older live with men without being married or widowed, separated or divorced (Ocampos, 1994).

Rural poverty can be analyzed in the light of internal and external structural causes. The principal cause is the difficulty in accessing land of sufficient quantity and quality. Additional causes include financial needs, such as credit assistance required for the purchase of tools, seeds and support for the family while it awaits the harvest. Adequate roads and centers for storage of production are needed, as well as assistance in matters of commerce. To the strictly economic factors referred to previously, specific social deficiencies must be added. As Michael Lipton has put it, "There is a limit to which technology can cure social pathologies (cited in Conway, 1999)."

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[5] Nutraceuticals are plants that provide pharmaceutical as well as nutritional factors and are often called dietary supplements or functional foods.

Collective effort is uncommon in Paraguay. The imposition of authority is the better-known system. Centers for discussion and debate, such as public libraries and town halls do not exist, therefore, the value of cooperation or of cooperative societies, despite the efforts undertaken in this area, are largely ignored. This is perhaps a partial explanation for the limited presence of the cooperative sector (Fretes et al., 1993).

Finally, the restricted social security system, the non-existence of agricultural and employment insurance and the lack of other expressions of social solidarity contribute negatively to the overall poverty picture. Aside from the levels of unemployment or extreme poverty characteristics of the population in the rural sector, in which the majority are unsalaried family workers, in the urban sector only 76% of the economically active population is employed and 18.5% is underemployed. Only 5.0% are fully unemployed (Gutiérrez, 1998).

Many factors hinder the possibility of providing more productive activities that occupy labor, these include: little available capital, the high cost of capital, rigid labor loss, a huge bureaucracy, administrative corruption, a limited market and a justice administration – now under revision – which does not allay fears of insecurity. Paraguay's porous borders offer contraband as a viable alternative for making a living (World Bank, 1992).

As a result of the above, unemployed labor opts for two choices: emigration (in Argentina alone, 39.2% of immigrants are Paraguayans), and the "informal sector," which according to estimates comprises about 40% of the work force. This indicates a need for maintaining people in rural jobs, especially small-scale farming, unless something can be done to curb population growth.

Paraguay fortunately has not experienced serious ethnic or social discrimination and has no major obstacles that prevent social mobility. Socially, it is a democratic society. In present-day life, however, certain structures of inequality are created, particularly arising from a progressive differentiation of opportunity, which need to be overturned to avoid unwanted consequences in the future. The rural sector, subject to the whims of the market, adverse climate, difficulties in obtaining credit and land, and being geographically dispersed are harder to reach with social services, may be the most challenging sector to integrate into the country's economy. Youth, which accounts for a large segment of the population require conditions for entry into the labor market, education, health and leisure. This sector presents great challenges for social integration.

Conditions at the Study Sites

Paraguay's eastern region is better suited climatically for agriculture. This region contains an extensive plains region, hilly areas with fertile valleys and low plateaus. The soils vary from sandy oxisols and some clayey ultisols called "high red camp" in South Eastern Paraguay, to many areas near the Paraguay River that are low-lying and swampy. The climate of the eastern region is considered continental sub-tropical.

Aguaity, Eusebio Ayala

This site is located some 80 km southeast of Asunción. The first 64 km are on paved road No. 2, and the remaining 16-km are dirt roads. Average annual rainfall is 1,400 mm. There is an average of 75 annual rainfall days during the year and these are fairly well distributed. The Thornthwaite humidity rate for the area is between 20 and 40. That is, average annual rainfall is above average annual potential evapotranspiration. Therefore, it is classified as humid. The absolute minimum temperature is -1°C and the

absolute maximum temperature is 41° C. "Winter" in Paraguay lasts from late May through September. During cold spells, temperatures vary between 4 and 10°C and they can drop as low as -1°C. These spells occur very infrequently and last for only a few days at a time. They are interspersed with warm spells during which temperatures can reach 32 degrees C° during the daytime (Grassi and Yorki, 1988).

Topographically, it can be characterized as a hilly area with both steep inclines and softer rolling hills. Agriculture conducted continuously on these slopes and the sandy texture of the oxisol soils is responsible in part for the high degree of deterioration found today, along with the mistaken practice of cotton monoculture. The area's oxisols are derived from sandstone. This sandstone crops up above the surface, especially on hillsides. The area is almost totally deforested except for some highly degraded patches, some riparian forest and a few plantations.

Around 600 people populated the study site. Most of these had small farm plots (minifundios) and many had off-farm income.

Ñu Pyahú

This site is located 250 km east-southeast of Asunción. The first 180 km are on paved roads, and the remaining 70 km are on dirt roads. Since the study was conducted during the drier "winter" months, the roads were in fairly good condition. However, many people I talked with told me that these roads were impassable during the rainier season. Mean annual rainfall is 1,600 mm. There is an average of 92 annual rainfall days during the year and these are fairly well distributed. The Thornthwaite humidity rate for the area is 50. It is thus also classified as humid. The absolute minimum temperature is -5 °C and the absolute maximum temperature is 40°C. "Winter" conditions are similar to

those described above for Eusebio Ayala, except that the occasional frosts are harder (Yorki and Grassi, 1988).

Soils in Ñu Pyahú are mostly oxisols, with some ultisols and patchy spodosols. Since the farm sizes are larger, they have been allowed a normal fallow period until fairly recently. These oxisols as in Aguayty, are sandy loams with slightly higher clay content on the top of hills. Topographically, it is an area of rolling hills and extended plains. Ñu Pyahú itself lies nestled between large cattle ranches that use the native *Andropogon* sp. and *Paspalum* sp. grasses for grazing. These are mostly cow-calf operations of low productivity and are not included in this study. The area has little forest. However, many farmers have a patch of between one and five ha of forest on their land. This is logged for personal use and incidental needs.

There are between 70 and 75 houses in Ñu Pyahú. Five of these are apparently abandoned. The total population was around 450, although an exact number was impossible to establish. Most of the inhabitants were farmers and their average farm size was 12 ha (non-minifundio). Some had seasonal off-farm income.

In Chapter 3, the relationships between medicinal plants, healthcare and the environment will be explored. These issues will be discussed in both the global and the Paraguayan national context.

CHAPTER 3
MEDICINAL PLANTS, CONSERVATION, AND DEVELOPMENT

Introduction

Increased demand for medicinal plants has led to the extinction of a number of medicinal plant species. A recent World Bank study *Medicinal Plants: Rescuing a global heritage*, finds that community conservation practices including the use of protected areas, community awareness and training, plant research, and documenting the knowledge of traditional uses are critical to the long-term use of these important plants (Lambert et al., 1997). "Ex-situ" conservation, has been identified by the World Bank as the main hope for maintaining supplies of today's levels of botanicals needed for use in healthcare by the estimated four billion people who rely on them (Lambert et al. 1997, Farnsworth 1991).

> Ideally, all medicinal plants species should be conserved as evolving populations in nature. However, these species should also be conserved ex/situ (i.e. outside their habitat) as well. The primary purpose of this is as an insurance policy. But it also has the advantage that it is usually easier to supply plant material for propagation, for reintroduction, for agronomic improvement, for research, and for education purposes from ex-situ collections than from in-situ reserves. The disadvantage of ex-situ conservation is that the sample of the species conserved ex-situ may represent a narrower range of genetic variation than that which occurs in the wild. Species conserved ex-situ can also suffer genetic erosion and depend on continued human care. For this reason ex-situ conservation must not replace, but should complement in-situ conservation. Most of all, ex-situ conservation should not be used as a reason for failing to safeguard representative samples of the medicinal plants and their habitats in nature. Priority for ex-situ conservation should be given to species whose habitats may have

> been destroyed or cannot be safeguarded. It should also be used to bulk up populations of depleted or even locally extinct plants for restocking in nature. In some countries it may be appropriate to conserve all medicinal plants ex-situ, in others, where for example some medicinal plants are common weedy species, this may not be necessary. With medicinal plants it is particularly important to conserve a broad genetic base to permit improvement in the cultivated material. When collecting the plant material for ex-situ collection care should be taken not to put the survival of the wild population at risk (as a general rule, no more than 20% of the available seed of a population should be taken). (Sheldon, 1997)

In Paraguay, as in other developing nations, approximately 80% of primary and last recourse healthcare needs are met with medicinal plants (Moreno Azorero 1987, Farnsworth 1991). The interesting fact about the Paraguayan case is that nearly the same percentage of the population consumes these raw medicinals and nutraceuticals on a *daily basis* (Moreno Azorero 1987, Favitski 1997, Basualdo pers. comm. 1999). Not surprisingly, and in keeping with research in other parts of the world, a large proportion of the plants are gathered from the wild (although some are grown in home gardens and flower pots or intercropped in fields). This chapter will review some important current international trends relating to medicinal plant issues worldwide. Special emphasis is placed on how awareness of the relationship between medicinal plants and the environment can work positively towards conservation and development. It is expected that some basic groundwork can be laid, upon which policy makers may draw when need arises for changes in current management practices. After describing different global aspects of medicinal plants, the Paraguayan situation is described regarding each one of the points addressed.

Traditional Medicine, Healthcare, and the Environment

Plants for healthcare are harvested in many parts of the world, especially in developing countries. In some cases, over harvesting of the Non-Timber Forest Products (NTFPs) leads to loss of biodiversity at the species level. In other areas, ecosystem degradation due to logging, clearing for pastures, urban sprawl, drainage of wetlands and other anthropogenic alterations, cause the loss of habitat where medicinal plants can grow and where they are easily accessible by common people.

In any nation in which traditional healthcare systems are used, the link between local communities and the landscapes where they live is inextricable. The option to train long term professionals in traditional healthcare often hinges as much on the probability of there being enough health care plants available in the mediate future, as on the acceptance or not of these practices by the scientific communities of each country. Often, women are the primary healthcare providers and the reservoirs of knowledge of traditional use (Lambert et al., 1997). Changing gender role patterns in the developing countries may lead to an interruption in the chain of passing down of knowledge, which is often (though not always) from mother to daughter.

Many societies are going through the recovery of traditional knowledge in health care after the botanical know-how was forgotten or even suppressed in many countries. This knowledge, the "interrupted tradition of natural medicine" may be recovered through the study of ethnobotany, in this case called "salvage ethnobotany" (Sheldon et al., 1997).

Recognition of Medicinal Plants as an Important Natural Resource and Healthcare Issue

A pivotal conference that pushed the issue of medicinal plants and conservation onto the world stage was organized by The World Health Organization (WHO), the International Union for the Conservation of Nature (IUCN), and the World Wild Fund for Nature (WWF), held at Chang Mai, Thailand, in 1988. Among other things, the document recognized that medicinal plants are essential in primary healthcare, both in self-medication and national health services; that they are being lost at an alarming rate; and that this could have dire consequences. The document drew the attention of member states to the vital importance of plants to healthcare; the increasing and unacceptable loss of these plants due to habitat destruction and unsustainable harvest practices; the fact that plant resources of one country are often of critical importance to other countries; the significant economic value of medicinal plants used today, and the great potential of the plant kingdom to provide new drugs; the continuing disruption and loss of indigenous cultures which often hold the key to finding new medicinal plants that may benefit the global community; and the urgent need for international cooperation and coordination to establish programs for conservation of medicinal plants to ensure that adequate quantities are available for future generations (Akerele, 1991).

Regulatory Agencies and Conventions

The Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES) is a treaty that has been in effect since 1975 to curb markets for endangered species. A drawback of this system is that often, by the time a plant makes it to the list, its population is already severely decimated and its survival as a species is

greatly at risk. A further commission was created called the Species Survival Commission (SSC) of the IUCN. In February of 1994, it presented a document "Criteria and Requirements for Sustainable Use of Wild Species" to the General Assembly of the IUCN. The assembly concluded that the guidelines were too difficult to apply and that they were too broad in their scope as well as needing further clarification. As a result, the SSC began looking at case studies searching for possible indicators rather than broad general outlines. In May 1994 the SSC recommended that a Medicinal Plant Specialist Group be formed. The group's main focus is the ethical considerations related to prospecting for new drugs, and the creation of a conservation action plan with both taxonomic and geographic focus.

While CITES attempts to control the conservation of medicinal plants at the species level, this is often difficult due to the problems associated with identifying a particular plant or cultivar, especially in ground or powdered form. The SSC and World Bank have taken the initiative of addressing both ecosystems and species level conservation.

Projects that Involve Medicinal Plants and Conservation around the World

The Sri Lanka Conservation of Medicinal Plants Project

On December 17th, 1997 the World Bank announced the approval of a U$ 4.57 million grant from the Global Environment Facility. The project was aimed at medicinal plant conservation and sustainable use, based on high levels of use in Sri Lanka, and the fact that many species are endemic. This project is the first of its kind approved by the World Bank. Though the Bank had supported the enhancement of technical skills and

institutional development in Sri Lanka through the Forest Sector Development Project and the Environmental Action Plan, this project focuses on the long-term viability of Sri Lanka's medicinal plants by:

1) Establishing five protected areas – Medicinal Plant Conservation Areas (MPCAs) – to conserve species of medicinal plants found in the wild. MCPAs act as focal points for cultivation, research, raising awareness for the importance of conservation and documentation of traditional knowledge of the plants and their uses; 2) Increasing nursery capacity to research the suitability of cultivation of select species; 3) Collecting and organizing existing information on plant species and their uses; and 4) Promoting the appropriate legal and regulatory framework through draft regulations to ensure the protection of Intellectual Property Rights.

> Considering that the total medicinal plant collection of Sri Lanka meets only 40% of the domestic demands – the remaining 60% is imported- there is great incentive for Sri Lanka's rural poor to over harvest the fragile and limited supplies in the wild without much awareness of the sustainability of the species. (Nadim Khouri and Malcolm Jansen, 1997)

Besides the very comprehensive and well-funded Sri Lanka project, other efforts are underway in several tropical countries aimed at the conservation of medicinal plants. These include several schemes and different relationships between government, non-governmental organizations and local communities. A few that deserve highlighting are the following.

Extractive Reserves in the Brazilian Amazon

This is a new type of land-management system that arose in the Brazilian Amazon when the rubber tappers protest movement culminated in the assassination of Chico

Mendes in 1989. Since then, many extractive reserves were modeled after the original Chico Mendes reserve in the state of Acre, Brazil. Based largely on the extraction of two species of NTFPs by rubber tappers who act as stewards of the forest. The early models were based exclusively on rubber (*Hevea brasiliensis*) and Brazil nut (*Bertholletia excelsa*), some have recently decided to diversify the list of products that can be extracted to include medicinal plants.

The Belize Ethnobotany Project

This project began in 1988 in the tiny Central American country. It is a collaborative effort between The New York Botanical Garden Institute of Botany, the Ix Chel Tropical Research Foundation in the Cayo District, the Belize Center for Environmental Studies, and many other governmental and non-governmental organizations. A 2,400 ha parcel of forest received the status of "ethno-biomedical forest reserve" in 1993. Within this reserve and from other areas of Belize, plants are classified and "rescued" by transplanting to safe areas on private farms. Although recent political and economic changes have caused setbacks in the original program, local healers and scientists continue to do research – including the supplying of bulk samples for testing for the National Cancer Institute (NCA-USA), (Sheldon et al., 1997).

AMETRA 2000

"Aplicación de Medicina Tradicional" (Application of Traditional Medicine) is an on-going project in the Madre de Dios region of the Peruvian Amazon. It is a community-based project that revolved originally around one plant, the ojé tree (*Ficus insipida*) a powerful anti-helminthic. More than 100 species of medicinal plants are currently under cultivation at the site. Although the principal objective of the project is

healthcare for the local population, supply of wild plants is an important issue. The ojé tree is a dwindling species in the wild, and the project is focusing on forest stewardship by the local people as a way of maintaining a harvestable stand over time.

Community Development through Medicinal Plant Projects

The success of community level production projects and commercialization schemes are documented in several countries. A brief description of three successful projects is given here in search of a model, which could prove suitable for Paraguay. The marketing of raw, but clean and well-presented medicinal plants may be more suited to small rural projects instead of high tech industrialization, which by its very nature, may be big business for large companies. These two approaches are not necessarily exclusive, and the proper identification of communities for projects and the right project for certain communities are crucial to the their success or failure. Projects may be grouped according to their main objective. Some seek grass-roots community development above all. Others consider cash income, environmental services or sustainable development as fundamental. Still others are basically conservation oriented. Those who focus on healthcare as a primary goal are apparently fewest in number. Those projects that can balance all of these objectives have the greatest possibility for long-term success, as conservation and development are two sides of the same issue and cannot be separated.

In the Sri Lanka Medicinal plant project mentioned previously, awareness for the preservation of medicinal plants will be increased through training and education activities. The MCPAs will ensure that benefits of the project are felt in those rural communities. A dispensary staffed with an Ayurvedic physician and information center will provide appropriate medicines and information to the surrounding communities.

In the Brazilian "Cerrado," medicinal plants have been used as the basis for community development, health, the environment and sustainable development. The "Centro Comunitário de Plantas Medicinais: Comunidade do Cedro" is a project currently underway in the Municipality of Mineiros in the State of Goias. This is a community where the social network and identity dating back to the slave days had been waning for decades.

One of the cash generating activities was the small-scale manufacture of medicines derived from local plants. A committee formed especially for this purpose sought local knowledge through interviews with some of the elder locals. A small plot of land was later obtained to function as an introduction and reproduction garden. At the same time, workshops were held on the plants of the cerrado ecosystem and on their handling.

The positive results of this project have made it into a role model for other communities from surrounding areas as far away as the State of Minas Gerais. The community received low cost, good quality, and low toxicity medicines. Aside from this, the project opened up a physical space that was beneficial in providing appropriate conditions for the handling of the plants and at the same time strengthening internal social organization. The "re-learning" of such traditional practices as "mutirão" (joint work) greatly improved attendance at community meetings (Ioris, 1999). Currently, the project is seeking a more systematic agronomic assistance for its producers. It is interesting to note that at the time of implementation, the organizers were not able to find one agronomist in the entire region who possessed knowledge of the agronomic aspects

of cultivating medicinal plants. As in many other projects of this type, conservation of natural habitats is a by-product or secondary objective.

Healthcare, Medicinal Plants, and Conservation in Paraguay

In Paraguay, health services are severely limited in rural areas. Problems include a lack of adequate health centers; concentration of medical personnel in the cities; the high cost of drugs, and the high cost of medical personnel. Social indicators for the health sector only partially reflect this situation.

Table 3. Paraguay Health Indicators

Crude birth rate (per 1,000)	35
Crude death rate (per 1,000)	7
Infant mortality rate (per 1,000 live births)	42
Population per physician	1,800
Population per hospital	700
Access to safe water (percentage of population)	
Urban	46
Rural	10
Calorie intake	2,873
Per capita protein intake (g/day)	81.0

Source: World Bank, 1992

Medicinal plants are healthcare inputs. Although there are probably less endemic medicinal plant species than in the Sri Lanka case mentioned above, many are in fact unique to this meeting of tropical and sub-tropical zones. Massive loss of habitats and

high rates of consumption are other reasons to support a medicinal plant project. While population density is nowhere near Sri Lanka's, the growth rate of 3.2% per annum in Paraguay is the highest in the Southern Cone of South America (World Bank, 1992). The opportunity to use the medicinal plant issue as a driving force for conservation and development is present and should not be overlooked. Their importance for cultural identity in Paraguay is on a par with that of the Guaraní language. Prance has insisted upon this aspect of medicinal plant study:

> We also need to bear in mind the vital role of conservation of culture, as well as biodiversity. To my mind, biodiversity gets too much attention compared with cultural conservation. We should be asking ourselves: how can our work in ethnobotany help to maintain cultural identity? (1994)

Threats to Medicinal Plants

Deforestation

The loss of forests, especially rainforests, is particularly worrisome on this subject as they contain by far the highest biodiversity per unit area in the world. It is a widespread, though unproven tenet, that many of these may be potentially useful medicinal plants. An annual worldwide loss of an area five times the size of the Netherlands serves to help visualize just how rapidly species and ecosystems are being lost.

Paraguay is not immune to the ravages of deforestation. Most "campesinos" or small-scale farmers live in the Eastern Region. In this area, from the 1950s, when measurements began being taken through aerial photography until the mid 1990s, it is estimated that 90% of the original forest was lost. Much of this was due to logging, the expansion of the agricultural frontier, and misguided government policies, which

encouraged landholders to improve their land to avoid its being subject to expropriation for land reform. As in many other countries of Latin America, this led to the falling of great tracts of forest (200-500 ha at a time) for the establishing of monoculture cattle grazing ranches.

The western or Chaco region was less developed until recently. A handful of Anglo-Argentine tannin companies, along with a few Paraguayan large landholders practiced extensive cattle production for the canned meat industry (Liebig's Extract of Meat Co., and other large British firms), on the natural flood plain near the Paraguay and Pilcomayo rivers. This area is populated by the palma or karanda'y (*Copernicia alba*). It is only within the past ten years that Brazilian ranchers have moved into the Alto Paraguay region and begun large-scale clearing (using bulldozers and anchor chain) of sub-humid and semi-arid forests. While Mennonite immigrants had been clearing the central Chaco since the 1930s, their plots were usually small and family run. The Brazilian-owned ranches on the other hand, are commercial operations. The rate of these new land clearances could have potentially devastating impacts for the conservation of little-known Chaco indigenous medicinal plants. Both types of clearance i.e. aggregate family size clearings, and large commercial clearings have a devastating impact on the environment.

Loss of Indigenous Knowledge

The Northern Chaco is home to the last group of hunter-gatherers that have not yet come into contact with "white man." They are the Totobiesiogode. It is estimated that there are only two or three groups of between 25-50 persons each in these clans. Their knowledge of medicinal plants of that region, especially the powerful steroid abortificants

is being lost at the same rate as the massive deforestation of their ancestral lands (Arenas and Moreno, 1977). The preservation of this knowledge for all generations to come and especially for the Totobiegosode and other small tribes, depends largely upon the recognition of indigenous rights and the setting aside of large tracts of their ancestral lands in perpetuity.

Urban Sprawl

In countries where deforestation has long ago ceased to be the main factor to the loss of habitat for medicinal species, such as China, a new menace confronts small farm plots and home gardens as well as forests and fields. This new threat is urban sprawl. Much of the best land around Beijing and other major cities is becoming urbanized. This process can also be seen in the Central Valley of California – some of the most fertile agricultural lands in the world - and in Malaysia and Indonesia, where much prime peri-urban farm and forestland has been lost to the construction of golf courses. The need to feed the population has led to massive (and quite successful, from the production point of view) drainage, flooding schemes for rice cultivation in countries that have been recovering from generations of war, such as Myanmar, Vietnam, Laos and Cambodia. These infrastructure works, so necessary for local food security, often overshadow the perceived lesser need for health security from natural medicines. As lands go to rice, habitat is lost for many of the species formerly in normal use by the general population.

Several factors along the time line of Paraguayan history have saved it from the blight of the megalopolis. Asunción, the capital boasts a population of only 650,000 in the city proper, and around 1.2 million in the metropolitan area. Only four other cities have populations of more than 100,000. There is no such thing as suburbia. Therefore,

the threat of loss of ecosystems due to urban sprawl in Paraguay is not urgent. The rate of migration to the cities, however, is steadily rising. Just fifteen years ago, the rural population of Paraguay was nearly 70%. The 1992 census undertaken just before the elections showed that only 49% live in the countryside. This could pose another kind of threat since many newcomers to the city do not have secure jobs. While they continue to wish to drink their daily medicinal herbs, they are unlikely to be able to pay for them. This may place great pressure on fields and riparian habitats surrounding the greater Asunción, which according to some sources, have already been stripped of much of their former wealth of medicinal plant biodiversity. It is essential therefore that conservation projects contemplate suburban and peri-urban areas along with rural areas. Studies into the rate and direction of conversion to urban land uses are needed.

Community Development in Paraguay

In the "Centro de Promoción de Campesinos de la Cordillera" (CCCP) project mentioned earlier, one of the crops under consideration to be promoted was medicinal plants as an understory crop for nurseries and home gardens.

One aspect of this now defunct project, which deserves highlighting, was the "campesino-indígena" (small-scale farmer-indigenous) meeting that was organized in 1990. During this three-day workshop, native indigenous groups from eastern Paraguay were invited to the Cordillera. The objective of this meeting was to help resource-limited farmers recover or re-learn the names and uses of many plants of different habitats, which have been forgotten during the many years of cotton monoculture. The meeting proved highly successful (Fretes et al., 1993). Some of the knowledge of Guaraní cosmogony was transmitted to the local farmers during this event. Among other benefits were a new

found appreciation on their part for native species and the role that each one plays in contributing to a more healthy, sustainable environment.

Summary

Traditional medicine, healthcare and the environment have been linked together by many of the world's most important multi-lateral organizations, NGOs, multi-national corporations and national governments. Paraguay must construct its system based on its own unique components and the peculiar interconnections among them. The recognition of the tremendous importance of medicinal plants in maintaining the health status of the population is the logical first step. Recognizing that plants needed for this natural medical care system are being lost at an alarming rate due to habitat destruction should lead to policies that tend to protect biodiversity in the general sense, and especially regarding the botanical pharmacopoeia so important to Paraguayan cultural identity and healthcare. The very real threats of deforestation, over harvesting, and to a lesser extent, urban sprawl, should be dealt with within this context.

Ownership of medicinal plant intellectual rights, is a crucial issue especially when native and remote tribes are the source for medicinal plant knowledge. However, since plants and remedies used by "campesinos" are in the public domain, the issue is less important in the context of this thesis. The government of Paraguay needs to set up rules to regulate the value and benefit-sharing potential of the enormous library of knowledge that is the Paraguayan culture of medicinal plants. The policy to be created must be uniquely Paraguayan. Reference points such as the World Trade Organization (WTO), Trade Related Aspects of Intellectual Property Rights (TRIPs), The Convention on Biodiversity (CBD), the National Biodiversity Institute of Costa Rica (INBIO) and other

relative agreements and projects should be taken into consideration when creating or enforcing policy.

Finally, all of the above will have the highest, most sustainable rate of success for the highest number of people if applied to community development projects. Grassroots, small-scale, organic production of medicinal plants – both native and introduced – in agroforestry and home garden projects is one way of achieving this. Experience from around the world indicates that through this means, the issues of biodiversity conservation and development may be resolved with the least cost and highest return for all stakeholders involved.

CHAPTER 4
MEDICINAL PLANT USE IN PARAGUAY: IMPORTANCE, HISTORY, AND NUTRITIONAL ASPECTS

The Natural Life

Doña Zenona González sat in a comfortable yard chair just outside her small private rancho. She was enjoying the sun's heating rays on this brisk July, Paraguayan morning. I had been talking at length with her son Juan (55), on many aspects of farming in and around Aguaity, Eusebio Ayala. As we walked into his home garden so he could show me his medicinal plants he mentioned – almost as an afterthought – that his mother, who lived near their home garden in a small house of her own, was 102 years old, and still had use of all her faculties. Apparently, my nod of acknowledgment was one of disbelief. Juan immediately took out his wallet and proudly displayed his father's birth certificate. The folded, sepia-colored, hand-written paper stated the year of his birth, 1888. "He passed away in 1978, he lived a long healthy life, but my mother is even healthier! Come, let's go see her." Frail and well wrapped against the chill, Doña Zenona smiled an almost toothless smile when I asked her what had kept her going for so long.

> I eat kamby (milk), so'o cu'í (ground meat), eíra kesú (homemade cheese with honey), ryguasú rupi á (eggs), rorá kamby (corn bran with milk), mbeyupé armiró (flat manioc starch cakes) and dulce de mamón con leche (papaya preserves with milk).

She specified that she never or rarely ate sugar and flour. Unknowingly, she was telling me that she consumed a diet of unprocessed or little processed foods. She had never heard of modern medical trends towards high fiber, less sugary and less floury foods. Nevertheless, her wise traditional ways were – or so it seemed to me – the very essence of what health specialists preach today.

> Oh, and one more thing. I never forget my herbs. I have consumed verbena and virá virá guasú all my life every other day. This is what keeps me young. The only supplement I buy is vitamin B 12 and that only started a few years ago.

The following week it was time to head for my comparative study site, Ñu Pyahú, 200 km to the Southeast. As we arrived in the dusty, treeless hamlet, it was apparent that we were not going directly to the home where we would be staying. Doña Clemencia Escobar (51), and her son Fransisco (14), my travel companions, had a birthday party to attend. There were several cars and pick-up trucks arranged in haphazard fashion in front of an unpainted plank, thatch-roofed house. Doña Isabel Torres was receiving an honor that for a long time had been reserved for her husband, who had passed away the previous year. In honor of her 83rd birthday, her daughter and son in law had slaughtered a young heifer. Although no invitations had been sent, they knew that many would come as Doña Isabel had touched many lives en route to this birthday. As I had done with Doña Zenona, I asked this woman what she had eaten and drunk to live so long.

> I always ate tupí cu í (cracked corn), my mother grew taya ó (*Equinodorus paniculatus*) and I always ate home cooked food, like typyraty (a sub-product of manioc starch processing). When I was first married, we lived in the *disierto* (desert: by this she referred to the isolated area where her husband had taken her to settle for the first 13 years of married life). I never ate much beef, but I did eat meat. I especially ate a lot of "paloma barrero" (dove from a salt lick). In fact, all the meat we ate during that time was from a salt

> lick. My husband would bring home dove, deer, armadillo and even tapir, back then. It was so easy to find. As for medicinal plants, I have always taken verbena every day before breakfast. I often take rue as well.

All this she related to me in a comprehensible level of "yopará." This is the mixed language – more Guaraní than Spanish – that so many speak in Paraguay.

The fact that I was concentrating on medicinal plants brought an intriguing question to mind. Of the three plants these two elderly women claim to have aided them in obtaining their longevity, two were of European origin. When did the syncretism with Guaraní culture begin? Could this knowledge have been passed down exclusively by word of mouth? Furthermore, I found more and more species of Paraguayan plants that people normally consume. I wondered, how, with less than 2% of the population being indigenous (and having been that way for a long, long time), and with more than 2/3 of the original population wiped out in the genocidal war of 1865-70, names, recipes and uses of so many plants seemed to be known and understood by so many of the common country-folks I interviewed. There must have been some sort of systematization along the line. I needed to take a closer look at how ancient knowledge had reached so many and indeed, remains so popular and well respected – even by many physicians – in modern day Paraguay. Regarding the maintenance of knowledge, Sheldon, Balick, and Laird (1997) have written:

> In some cultures, the knowledge of how to use plants medicinally is shared by all members of a community, whereas in others it is guarded by a carefully trained few. As a result, there are many different ways ethnomedical information is transmitted from one generation to the next. The cumulative body of knowledge can be concentrated in healers who are respected and central members of the community. It may also be stored in the detailed oral traditions of a people or in elaborate medicinal volumes such as the Ayurvedic texts of the Indian sub-continent. In other cultures, the knowledge

of the medicinal uses of plants is a thinly spread residue of folk medicine, weakened by colonialism or other fragmentation.

Introduction

The unique situation of political and geographical isolation that Paraguay underwent throughout much of its history is one of the main influences on the persistence and extent of medicinal plant use. The cycle of use, starting with only wild, then cultivated medicinals, over to western manufactured pharmaceuticals, and a slow trend back toward more natural remedies (interrupted natural medicine) in many other parts of the world is in contrast to Paraguay's case. Here there was no interruption, but rather, traditional and modern pharmaceuticals exist side by side, with traditional healing taking the higher spot in the rural areas. It is possible that a better understanding of some of the reasons why the use of home-grown or gathered botanical elements for mostly preventative, but also therapeutic medicine is so widespread in modern-day Paraguay, may have policy implications that will benefit the health security of small-scale farmers.

There are two basic and quite distinct types of medicine practiced worldwide. The most common form known to westerners of the developed countries is allopathic medicine. This is the treatment of ailments *post-facto*, or once the symptoms characteristic of a disease manifest themselves. The other type of medicine is a group of medical practices known as natural or alternative medicine. While Paraguayan Traditional Medicine is often called natural or alternative, it does not exactly fit into these narrow categories. One type of natural medicine, in which minute quantities of medicines (usually – but not always – natural or herbal) are taken *a priori*, on a daily or weekly basis, before disease strikes, is usually called homeopathy. Although homeopathy has

become more popular in modern western developed societies, sometimes as a fad, in the tropical and subtropical developing world, a form of health maintenance and preventative medicine, which is not strictly scientific (European) homeopathy, uses *homeopathic* (minute and frequent) *doses* of natural products for preventative medicines. This is the essence of Paraguayan Natural Medicine. Therapeutic plant medicine also exists.

Modern Paraguay

In modern Paraguay, vendors of medicinal plants can be found on many street corners of any one of the major cities and towns. The vast majority of the population consumes yerba mate (*Ilex paraguariensis*), known as Jesuit tea or Paraguayan tea on a daily basis. This tea is drunk differently from the more commonly known coffee and "English tea." Instead of being prepared separately and then served in cups, Jesuit tea is consumed as a hot infusion called mate, or a "cold" infusion called tereré. Hot mate is usually drunk by pouring hot water onto the ground leaves of the mate plant in a gourd and sucking it through a metal straw with a perforated end (for straining), known as a "bombilla." This is usually consumed first thing in the morning and in late afternoon (especially in "winter" time). Similarly, tereré, the cold version of the same thing, is consumed at mid-morning and mid-afternoon by pouring cold or cool water onto the tea, usually contained in a special cow's horn or "guampa" and sucked through the same straw described above. Aside from the massive consumption of yerba mate (*Ilex paraguariensis*) itself, the method and frequency of drinking of these infusions lends itself very well to the additional intake of other herbs, roots, barks, etc. Mate and tereré drinking provide an excellent vehicle for introducing medicines into the human organism. One simply takes the prescribed (very often self-prescribed) medicinal plant parts,

pounds them using a mortar and pestle or other less conventional means (brick and curb, bottle and table), and adds them to the water to be used in drinking the infusion. The herbs are sometimes placed in the mate or "guampa" instead of the water but this is much less common than placing it in the water itself. The word cold is placed in quotation marks above to make a point. The infusion of refreshing leaves and roots used in the water for tereré drinking is known as "pohá roynsá" or cold medicine (not medicine for colds) in the Guaraní language. With the advent of modern technology (ice making) and the fusion of Spanish with Guaraní to form the bastard or pidgin "Yopará" (literally: everything mixed together), tereré began to be drunk with ice distorting the real meaning of the term "pohá roynsá." Originally meaning medicine that is refreshing to the stomach or depurative, it became cold (a reference to temperature) water medicine.

In cities, these medicinal plant parts are bought in bundles from local vendors. In the countryside, however, these plants are grown in the homegarden and gathered from fields and forests. Gathering forest plants was traditionally men's work. They were the ones who went off into the forest to hunt, clear land or undertake other activities. The growing and gathering of plants around the homestead is usually associated with women and children. Gathering is usually carried out during women's daily walks to haul firewood and drinking water. Women are the primary marketers of medicinal-plant materials. Mothers and grandmothers use herbal products in the home as well as sell them in the rural markets. Such materials make home healthcare affordable and provide much needed income. Sustainability of supply can be greatly assisted if women were included in the process of developing conservation and cultivation (Lambert et al., 1997). This thesis focuses on the possibilities of cultivation rather than gathering.

Medicinal Plants in Spain

The influence of Europe on medicinal plant cultivation in the New World cannot be overlooked. Iberian conquistadors and missionaries spread out across the central and southern parts of the Americas brought with them the plants from their native Spain and Portugal. These prospered when conditions were right and many cases became voluntary weeds. In other cases, adaptation to new climatic conditions was not possible and substitutes were sought out and found in the Americas. In Spain, most houses had a homegarden until the early 1800s. From 1492 until the 19th century, there was little addition of plants to the Spanish collection itself other than the significant number of plants sent to Europe from the New World. The major source of the Spanish pharmacopoeia itself was made up of a mixture of native Mediterranean plants common to southern Europe, the Middle East and northern Africa. Spices brought from the East Indies during the middle ages using the overland caravan routes through central Asia and plants brought up from the East Coast of Africa and other areas and introduced into Spain by the Arabs during their 800 year stay on the peninsula. Another source were spices and medicinals brought from the East Indies by the Dutch and Portuguese just a few years before the "discovery" of America. We find many of these plants in common daily use in Paraguay today. The difference between the presence of these plants in Paraguay and elsewhere, is that in Paraguay they are used daily not as spices, but as medicines. In Europe the frequency of the keeping of medicinal plants at home began a sharp decline in the early 1800s, with the advent of better hygiene and manufactured pharmaceuticals.

Today, as in most other areas of the world, there is a renewed interest and "revival" of traditional herb and medicinal knowledge.

Plant Exchange During the Conquest and Early Colony

The Spanish had shown an interest in learning about autochthonous medical science and using local fauna for this purpose. By royal decree (cédula) of January 11th, 1579, Phillip II ordered the coming to America of General Protomedics and ordered the study of the plants and natural waters that might have medical application. He also ordered seeds and herbs of any healing plant of high local prestige to be sent to Spain. Those practiced in the use of medicinal plants could obtain the title and diploma of "Herbolario" (herbalist) to practice their specialty. Dr. Francisco Fernández' magnificent ten volume book on the plants of Mexico was lost to a fire at El Escorial Palace in 1617 (Martín and Valverde, 1995).

At the same time conquistadors and explorers were bringing plants with them from the Old World, many of which became quickly acclimatized. Thus was born a confusion that pervades many of the early works written by the unskilled observer. In Paraguay, as well as southern Brazil, Misiones, Argentina, and Santa Cruz, Bolivia and the countries of the River Plate estuary, natural history and indigenous knowledge on plants and diseases were gathered and studied by naturalists and missionaries, principal among these were the Jesuits. Many members of this order were trained in medicine or other sciences. They wrote catalogs, recipe books and manuals – some finely illustrated – which were copied and widely distributed. In America, studies of nature and especially medicinal plants were undertaken principally in four main areas: Peru, Mexico,

Brazil and the River Plate. Great contributors were also travelers, naturalists and early scientists.

The Jesuit Period

The Jesuit State or Province that existed from the 17th through the 18th centuries in lower Paraguay is considered by some as one of the greatest social experiments in history (inspired in part by More's *Utopia*). During this time distance from home, coupled with scientific rigor brought over from Europe, allowed for the classification and description of one of the greatest known pharmacopoeias in the world (Martín and Valverde, 1995).

During the 17th century, novice priests were waived the required three years of Latin so that they could devote themselves full-time to the learning of the Guaraní language. A corps of orderlies (nurses) was organized early on with the specific task of learning all they could about the local plants, their properties and uses. Many of these nurses and later physicians had been trained in Europe, and had battlefield experience. While ignorant of the Linnean system of classification, nevertheless were able to use Theophrastian and Dioscoredean systems to describe and work with plants. In many cases, they found South American substitutes for European ingredients in recipes for poultices and infusions. Several modern authors have addressed this issue. "With regard to the loss of autochthonous knowledge supported by the tradition of use, it may be lost or kept definitively according to our participation to rescue it through the most scientific annotation possible (Pulido, 1993)." The Jesuits did just this in Paraguay. They wrote and published at least 30 books on Guaraní medicinal plants during the 17th and 18th

centuries. This has facilitated the passing down of indigenous knowledge through the generations by more than word of mouth. A list of publications is cited in Appendix E.

The Post-Jesuit Period

After Paraguayan independence (1811), just as Europe and North America were adopting manufactured medicines at a frenetic pace, Paraguay was totally isolated from the outside world. This was a political strategy designed to avoid annexation by neighboring Brazil and Argentina, and an ultimately greater menace: British interference in internal and continental affairs (Cardozo, 1977). This isolation was a strong force in the maintenance of native knowledge on the use, cultivation and gathering of medicinal plants.

The 19th Century

Geographic and self-imposed isolation effectively blocked out the arrival of modern medicines and medical techniques in the first three quarters of the nineteenth century. In fact, the great French botanist Bonpland –Von Humboldt's travelling companion – was imprisoned and then kept under house arrest by the dictator J.G. Rodríguez de Francia, to prevent the entry of outside influences and protect national natural knowledge from reaching the outside world, among other reasons (Boccia, 1999). Paraguay fought a war considered by some historians to be "the bloodiest war in history" (Chiavenatto, 1979). During the Triple-Alliance War (1865-70), the population of Paraguay was decimated. Reduced to one third of its former population (from 900.000 to 270.000), most survivors were women, children and the elderly. This drastic fall in population density may be part of the explanation of how medicinal plant use was

continued into the present century. The fact that many of the survivors were women (1:7 male/female ratio) suggests that knowledge of the use and growing and gathering were in the domain of women. Due to this destructive war, and additionally the Chaco war with Bolivia (1932-35), Paraguay had one of the lowest population densities in Latin America well into the late 1950s (World Bank, 1992). Slash and burn shifting cultivation was a sustainable practice until this time, and the availability of medicinal plants from forests, wetlands and fields was seemingly unlimited.

The Post-War Years

Another great scientist and promoter of Guaraní traditional systems of thought and knowledge of plants was Dr. Moisés Bertoni. This Swiss-Tyrolean naturalist, after having worked and published in his native country, came to Paraguay in the 1890s. He set up a home and scientific research station in the remote Alto Paraná Region of Eastern Paraguay. There he delved into many aspects of science, especially agriculture, and published a number of works including "Agenda y Mentor Agrícola," in 1926, and two volumes of "La Civilización Guaraní," in 1928. These books were printed on a press that he had installed at his home in Puerto Bertoni on the Paraná river. Bertoni was later called upon by successive governments in the 20th century to organize the agricultural school and Botanical Gardens of Asunción. Throughout Bertoni's works an insistence on the idea that the Guaraní Indians had good methods of plant use and agricultural knowledge is prevalent. His approach was way ahead of its time, even though he is considered to have been over enthusiastic in attributing a highly developed civilization status to the Guaraní. On medicinal plant cultivation he wrote:

> The Great World War raised a great interest on this continent for the cultivation of medicinal plants. South American pharmacies found

> it almost impossible to import what was usually needed. Therefore, cultivation was considered. For a time, it appeared it would be good business and *another possible cash crop* for our agriculture. Time was lost and the great opportunity passed. As usually happens, as soon as the danger was over, all haste was forgotten. Nevertheless, the lesson stands. Many believed, very soundly, that the sad occasion of war may return, and even if it should not, it will not have been in vain to have attempted to substitute many imported medicines with those that can be grown here. (1926, emphasis added)

Some or all of these scientists may have provided a link between past Paraguayan medicinal plant knowledge and the present. It must be recalled that even in the United States, until the early 20th century, Botany was considered to be a fundamental discipline of therapeutic medicine. As much of 80% of medicines were derived from plants at that time. Even today, three quarters of all medicines available are derived originally from – even though they may now be synthesized – plants (Akerele, 1991).

Institutional Research in Paraguay

The National University of Asunción was founded on March 31st, 1890. The majority of the new professionals went on to specialize in Europe and became eminent scientists in their fields (Báez, 1939). Even though pharmacognosis was never part of the medical school curriculum, many modern day Paraguayan physicians accept the use of medicinal plants, or at least are not vehemently opposed to it, as occurs in some other countries.

Today, the Institute of Research in Health Sciences functions with an unfortunately low budget at the Faculty of Medicine in Asunción. The head of this institute, Dr. Ricardo Moreno Azorero has for many years taken an active interest in medicinal plants. He is a well-known indigenist, and has contributed heavily to modern

scientific writings on medicinal plants, especially those of the Chaco Indigenous groups (Moreno Azorero 1977, 1986 and pers. comm. 1999).

As far as medicinal plants go, the most active areas of the university are the departments of Pharmacy and Botany, both of the Faculty of Chemistry of the Universidad Nacional de Asunción. Dr. María del Carmen Ibarrola and her group are currently researching the anti-depressive potential of *Kyllinga brevifolia Rottb*. This is a plant of the gramineae family extensively used in Paraguay in folk medicine. The group at the department of Pharmacology has confirmed the effects of the rhizome of this plant as an anti-depressive and stress reducer (Ibarrola, 1999 cited in ABC Color). At the same time, Dr. Isabel Basualdo and her colleagues at the department of Botany at the same Faculty are doing serious work on their own and with the Botanical Gardens of Geneva in the very important field of plant inventory and systematics. These findings are regularly published in the journal of the department of Botany "Rojasiana." Such works as "Medicinal Plants in Paraguay: underground organs" by Basualdo have appeared in Economic Botany (1995).

An inter-institutional project between the Botanical Garden of Paraguay, the Municipality of Asunción, Alter-Vida, an NGO, and the Botanical Garden of Geneva (CJBG) has published "Paraguayan Ethnobotany, Ethno-Botanically and Socio-Economically Formalized Inventory of Medicinal Plants Traded in the Markets of Asunción" (Didier et al., 1999). The emphasis on research regarding medicinal plants is obviously not located at the School of Medicine, but rather in the Faculty of Chemistry. It will be interesting to see in the future if collaborative research will be undertaken between the Faculties of Chemistry (Departments of Pharmacy and Botany), Medicine

(Institute of Research in Health Sciences), and Agronomy (Horticulture and Human Ecology).

The school of Human Ecology, of the Faculty of Agricultural Sciences, has had several students research medicinal plant use near their rural workstation at Piribebuy. The contribution of Maria Castillo de Favitsky in her 1997 thesis is enormous. In it she gives solid evidence of what so many had wrote about previously as intuitive knowledge. That is, medicinal plant infusions are not only medicinal but also nutritious. Here in the United States "nutraceutical," a term that describes any natural dietary supplement that is both therapeutic and nutritional is very much in vogue. Medicinal plants contain proteins, fats, carbohydrates, mineral salts and vitamins. A typical plant contains around 40 active substances in the vegetative stage and 60 in the flavoring stage (Ratera, 1996). This point has been suspected and known for a long time in Paraguay. González Torres 1986, Ratera 1996, Burgstaller 1987, and the Japanese Technical Cooperation Agency (JICA) 1988, among others mentioned it.

It is this nutraceutical portion of the medicinal plant consumption, i.e.considering them as foods, that is most intriguing. Paraguayans eat many greasy, hard to digest foods. Perhaps medicinal plants are an aid in liver function for digestion (Ocampos, pers. comm., 1999). The Japanese finding of the enzyme ardosa reductase in many medicinal plants supports this notion. This enzyme contributes greatly to proper liver function (JICA, 1988). Dr. Timothy Johns, of McGill University in Canada has worked for twenty years with the Maasai. He describes what he calls the "Maasai Paradox," this is similar to the French Paradox of southwestern France (and possibly the "Rural Paraguayan Paradox"). Among both these peoples, enormous amounts of animal fats are eaten.

Among the Maasai, they account for 80 % of the diet. Their staple is lard soup. Both the southeastern French and the Maasai of Tanzania and Kenya have normal serum cholesterol level. In the French case, it is known that flavinoids contained in red wine somehow keep cholesterol levels low. Among the Maasai, gums, sticks, barks and leaves are constantly chewed throughout the day. Dr. Johns' theory is that over the millenia man has selected plant products to eat for their anti-oxidant properties.

"Plant Materials Consumed as Normal Dietary Constituents may provide sources of nutraceuticals or dietary supplements with potential for commercial development. Low incidence of atherosclerosis and hiperlipidemia among African pastoral populations consuming whole milk as their main staple, and 60% or more of their calories as animal-derived, run counter to epidemiological evidence from other milk consuming populations. Anti-oxidant and lipid-binding properties of roots and barks that are added to high-fat soups and of gums and other plant masticants help explain this paradox. In addition as part of a participatory research program with Maasai communities in Ngorogoro district, Tanzania, we have documented species that are added to boiled milk to form a product called 'Orkiwa.' This product may improve milk properties by altering lipid composition or cholestrogenic properties of the milk. Elaboration of dietary supplements from plant products that can be harvested sustainably by local people can contribute to economic development within these communities (Johns, 1999)."

Elaborate experiments designed to deprive one group of medicinals while others consume them to see if those deprived suffered from more nutritional deficiencies are unthinkable under modern ethical standards (Hiebsch, pers. comm., 2000). Dr. Elisa Ferreira, professor of family nutrition at the School of Human Ecology in Asunción has

reported that there is very little undernourishment in Paraguay. In fact, the only place in the country where extreme malnutrition can be observed is in the poverty belts around Asunción and Ciudad del Este (Ferreira, pers. comm., 1999). Perhaps the tens of thousands of people who have migrated to the city recently do not have access to the medicinal plants they used to consume in the countryside. This possibility merits further research.

In her study, Favitsky (1997) found that 100% of those surveyed in 11 districts of Piribebuy consumed medicinal plants on a daily basis. Among her conclusions were that drinking tereré or mate is a cultural habit and not a vice. Nutrition enters very little in people's choice of plants to consume. And some of the main reasons they are consumed are that they grow all over, are accessible, are flavorful, and people have faith in the fact that they help one maintain themselves healthy. The knowledge of those surveyed on the possible nutritional value of botanicals was very low (Favitsky, 1997).

Table 4. Mineral and Vitamin Contents of *Dorstenia brasiliensis*

Vitamin or Mineral	Amount Contained per 100 g	Human Requirements*	Percent of Daily Requirement Provided
Vitamin C	2.9 mg	55 mg	2.5
Thiamine (Vit. B1)	0.0724 mg	1.17 mg	0.2
Riboflavine (Vit.B2)	0.865	1.67 mg	2
Calcium	144	840 mg	28.8
Magnesium	44.2	275 mg	13
Iron	17.3	6.5 mg	96.1
Sodium	11.9	1,116 mg	1.07
Potassium	296	900 mg	32.89

Source: Favitsky, 1997, analized at School of Chemistry, Universidad Nacional de Asunción, San Lorenzo, Paraguay, 1997. These data correspond to ground powder of the whole plant of Dorstenia brasiliensis. Dilution in water might diminish or modify their virtues (Favitsky, 1997). *Comparison to: U.S. male (25-50 years of age)

Cycles of Knowledge and Use of Medicinals in the World and Paraguay

A newly founded Institute that may exemplify a return to medicinal plant use in many parts of the world is the Institute for Traditional Medicine in Dar-es-Salaam, Tanzania (Ngowi, pers. comm., 1999). Western-trained doctors increasingly attend symposia on alternative medicine held at western medical facilities. The simultaneous use within hospitals of modern pharmaceuticals and medicinal plants is a norm in Thailand. Ghana is extremely advanced in this type of complementary use of both systems. Another example is the Rukararwe tree-planting project under the Bweranyangi West Ankole Diocese Bushenyi, Uganda. This is a church-sponsored project aimed at rescuing and disseminating traditional medicinal plant knowledge for the treatment of illnesses (Mugisha, pers. comm., 1999).

In 1998 many articles began to appear in North American medical journals. The New England Journal of Medicine (NEJM) wrote a scathing editorial against the use of dietary supplements. In contrast, in November the Journal of the American Medical Association (JAMA) printed a special issue covering alternative medicine. It contained six articles covering original research, review articles and editorials on herbal topics. Seven of the nine other American Medical Association (AMA) Journals published at least 16 articles on herbs the same week. In all, AMA published at least 22 articles dealing with herbs. In response to a call for papers, the JAMA received over 200 manuscripts and additional manuscripts were submitted to the other Archives journals owned by JAMA. In all, over 80 articles and editorials were published in the 10 JAMA journals including 18 randomized trials and systematic reviews covering over 30 topics, with authors from over 16 countries (Fontanarrosa and Lundberg 1998, cited by Blumenthal

1999). Despite the opposition of the also influential NEJM, it appears that medicinal plants for use in modern medicine are becoming more mainstream, even in the USA.

In general, around the world, widespread cultivation and gathering of medicinal plants declined as population density increased and land became scarcer. The knowledge and use of these plants was further left by the wayside with the appearance of European colonial powers pushing their products on indigenous populations and prohibiting or limiting use of local medicines. In many cases, this was due to incompatibility with European religious beliefs (Christians often considered local medicine to be "black" magic or witchcraft). Many drugs no longer in use in the first world were dumped on "third world" countries by unscrupulous multi-national pharmaceutical conglomerates, even to the point of recommending drugs for uses for which they had been strictly banned in the developed world (De Assis Pacheco, 1983). With high and rising costs of modern medicine all over the world, efforts are undertaken to rescue forgotten knowledge of medicinal plant cultivation and use. Finally, large multinational pharmaceutical conglomerates take over this native knowledge – rarely paying royalties to do so – and manufacture pill or liquid modern forms of traditional medicines which are then marketed around the world, even to the countries from which the plants originated. An example is the sweetener and diabetes medicine *Stevia rebaudiana B.*, native to Paraguay, and currently being produced in Southeast Asia, and the Peoples Republic of China for the Japanese market where it is a multi-million dollar industry. No benefits from these sales have ever reached a Paraguayan community. Intelectual property rights (IPR) have already been touched upon above.

Western-Trained Physicians' Attitudes

In order to help confirm a suspected trend in physicians' attitudes toward medicinal plants for this thesis, an informal survey was conducted among Paraguayan physicians between the months of September and October of 1999. The objective of the surveys was to find out about Western-trained doctors' attitudes towards medicinal plants. A short questionnaire was designed and sent to Paraguay. Thirty-one doctors answered the survey out of 54 that were sent (a 57.4% response). Thirteen specialties and 10 different countries of post-doctoral specialization were represented. This was assumed to be a representative cross sample of the current Paraguayan medical community. A deeper study of this phenomenon may be useful to the health status of Paraguayans.

The composition of the doctors surveyed was the following:

Table 5. Doctors Surveyed by Field of Specialization*

Psychiatrist	4
Gynecologist/OB	4
Internal medicine	4
Gastroenterologist	1
Endocrinologist/Diabetes	3
Pediatrician	2
Anesthesiologist	2
Urologist	1
Osteopath	2
Hematologist	1
General Surgeon	5
Pneumologist	1
Allergist	1

Table 6. Doctors Surveyed by Country of Specialization

USA	6
Denmark	1
France	2
South Africa	3
Brazil	4
Netherlands	1
UK	2
Mexico	2
Paraguay	7
Argentina	3

Table 7. "I believe that medicinal plants have therapeutic value"*

Answer	No. of Doctors	Percentage of Sample
Agree	24	77%
Disagree	4	13%
Indifferent	3	10%

Table 8. "I am interested in alternative medicine, especially medicinal plants"*

Answer	No. of Doctors	Percentage of Sample
Agree	19	58%
Disagree	5	16%
Indifferent	7	26%

Table 9. "I recommend the use of medicinal plants aside from prescription drugs"*

Answer	No. of Doctors	Percentage of Sample
Agree	14	45%
Disagree	8	26%
Indifferent	9	29%

Table 10. "I take medicinal plants myself with mate, tereré or as tea"*

Answer	No. of Doctors	Percentage of Sample
Agree	15	48%
Disagree	12	39%
Indifferent	4	13%

*Source for all tables: E-survey conducted by Norman Breuer with Paraguayan physicians in September-October, 1999. N=31

The relative open-mindedness of modern western-trained physicians towards medicinal plant use may be a result of the conditions mentioned above. This attitude could prove useful for a range of Paraguayan needs including healthcare, development, conservation, and cultural identity. If well-trained doctors faithful to the scientific method are receptive to something as primitive, or avant-garde as botanical remedies, it is logical to assume that this frame of mind is very prevalent among the lay population.

Homegardens, Healthcare, and Nutraceuticals

The nutraceutical component of homegardens can be seen when looking at some common systems in other parts of the world. Fruit trees such as guava, rambutan, mango, and mangosteen and other food-producing trees such as *Moringa oleifera* and *Sesbania grandiflora* dominate the Asian homegarden. A substantial proportion of food requirements (as high as 40%) is provided by the Javanese homegardens. It also produces more net income than the rest of the farm (Nair, 1993). Sommers (1978, cited in Nair, 1993) surveyed 40 households with homegardens in the Phillipines and found that they supplied all the households with the recommended daily requirements for vitamin A, vitamin C, iron, and calcium. Moreover, half of the households obtained a sizeable part of their thiamine, riboflavin, and niacin requirements from the homegarden outputs and resources. This well-rounded diet may be thought of in terms of preventative or homeopathic medicine arrived at empirically over the ages.

Obviously, many important elements required for health security at the small farm level come from plants grown around the homestead. In fact, it has been noted that: "the knowledge and use of medicinal plants for medicinal purposes dates from the very

apparition of man on earth. This is affirmed as, for their survival, early man had to enter into contact and learn to live in harmony with the only environment he knew, the natural one. Man, through trial and error, learned to know plants that prevented or cured his illnesses (Gordon, 1996)."

Okafor, (1981, cited in Nair 1993), conducted an analysis of the edible parts (fruits, seeds, and nuts) of the compound farms of southeastern Nigeria, and reported that most of them contained substantial quantities of fat and protein. Seeds of *Irvingia gabonensis,* nuts of *Tetracarpidium conophorum,* and the fruit pulp of *Dacroydes edulis* are rich in fat (44-72%).

A partial listing of some of the plants grown in Paraguay begins to draw the picture of an admixture of home-grown plants of native, European, and African origin, which are used as remedies for headaches, stomach aches, skin inflammations, and aches and pains in general. Some of these are: aloe (*Aloe arborescens)*; lemon grass – of African origin *(Cymbopogon citratus)* ; lemon balm (*Melissa officinalis)*; mints (Mentha sp.); castor bean *(Ricinus comunis)*; rosemary – of European origin *(Rosmarinus officinalis L.)*; sage, salvia – of European origin (salvia officinalis); nettle *(Urtica* sp.); rue (*Ruta graveolens*), and common valerian *(Valeriana officinalis)*. Most of the other plants are either native to Paraguay or to the region. Many are fruit trees. A list of species most frequently consumed and reported by farmers at Eusebio Ayala and Ñu Pyahú can be seen in the Appendix B.

One of the reasons that homegardens are kept is for the growing of the medical component of "household security." Household security is defined here as being able to provide enough food to feed the household throughout the year and enough medicinal

plants to cover primary needs of healthcare. The concept of household security embraces both, the much-researched area of food security, and the lesser-known realm of health security. The term security is sometimes used synonymously with "welfare."

The plants required for home treatments are obtained from several sources: they may be native species gathered in the forest, native or introduced volunteer species collected in agricultural fields and grasslands, or they may be native or exotic (sometimes naturalized) plants grown in homegardens. In tropical America, the use of medicinals has been influenced from three angles:

1) Native knowledge with interchange between different ethnic groups resulting from their nomadic origin;

2) Spanish knowledge with the adoption and incorporation of products and remedies from Europe after the conquest;

3) The influence of official medicine with the incorporation of some patent medicines such as analgesics, ointments and antibiotics (Gordon et al., 1996).

As self-perpetuating systems requiring little inputs (Nair, 1999), home gardens are the ideal context for the small-scale commercial growing of medicinal plants. Furthermore, many species normally consumed are arboreal (flowers and barks) and others only grow or produce well under shade (e.g. *Pteridaceae* sp.). The land a farmer will dedicate to growing medicinal plants is this area around the farmstead, appropriately called the home garden. Its precise composition as far as arboreal, woody shrub, herbaceous, and connecting (vine) species is beyond the scope of this study to determine. Suffice to note that these four kinds of vegetation (as well as others) all provide

medicinal plant parts and their combination aids in the creation of a suitable environment for the cultivation of a diversity of species.

Summary

Paraguay is in many ways an anomaly. Traditional knowledge of the extensive ethnobotanical tradition of the Guaraní Indians has been kept to this day to a high degree. Even most western-trained doctors are not averse to the use of these medicinal plants. In fact, many consume them in their daily mate or tereré. This has resulted from many factors, including:

1) The non-extermination of the Guaraní, who mixed or amalgamated with Europeans to a higher degree than in some other areas of South America; 2) relative isolation from the outside world due to geographic and political reasons, and an extremely low population density until the early 1960s (World Bank, 1992); 3) the custom of imbibing infusions of yerba mate several times daily, laced with other herbs – an ideal vehicle for medicinal plant consumption; 4) the early study and publication of many proto-scientific works on medicinal plants by laymen as well as Catholic priests from the earliest years of colonization.

For all these reasons, and due to the fact that there is a fifteen to thirty million-dollar annual internal market for medicinal plants, their cultivation should be seriously considered as an alternative for small farmers. Adoption of any technology is always more feasible, and the learning time quicker when "new" practices do not differ greatly from existing knowledge. Although the cultivation of medicinal plants on a large scale may be new, their use, and indeed the need for their use, has been highlighted in this chapter.

CHAPTER 5
FARMING SYSTEMS CHARACTERISTICS AT THE STUDY SITES: INPUTS FOR THE ETHNOGRAPHIC LINEAR PROGRAM

Introduction

There are many differences as well as similarities between the farming systems at Eusebio Ayala and Ñu Pyahú. However, the similarities seem to outweigh the differences, suggesting that farmers at both sites face many similar constraints, and count on similar resources. Principal differences among the constraints are less land available to farmers at Eusebio Ayala, and less access to market for those at Ñu Pyahú. In the latter case, this leads to lower prices for farm products and higher prices for purchased items. Otherwise, in the linear programs used here, several livelihood systems at both sites are considered one general livelihood system. Household differences will be brought out in the different scenarios tested to show the diversity of livelihood strategies within this general system as they respond to differing household socioeconomic resources. These are expected to lead to, or help identify recommendation domains for the cultivation and sale of medicinal plants. Most information for the models was gathered through the several methods of anthropological research. Thus the models are referred to as Ethnographic Linear Programs (ELPs).

Economic Analysis Using Ethnographic Linear Programming

Linear programming simulates complex small-scale farms to a high degree. The objective function utilized may vary. In this thesis, the objective function is the maximization of end-year cash available for discretionary spending (i.e., after purchasing basic necessities). Ethnographic data were elicited from farmers in order to construct a model to test different alternatives for obtaining higher levels of discretionary cash for family use. This tool, once mastered to a certain degree was an effective means of achieving this goal. Testing the feasibility of growing new cash crops for families in the study area through linear programming can suggest directions for further research and extension. Its use can save money for limited resource Agriculture Ministries in developing countries by providing a headstart towards specific groups to be targeted.

The specific ELP methodology used in this thesis involved the use of the Corel Quattro Pro 9.0 spreadsheet. Activities were put into columns. These included crops raised for consumption and sale, a medicinal herb garden, selling activities, remittances, a grocery buying activity (including meat), and cash transfers. Rows were constraints on the system and these included land, labor, consumption of various crops, and other foods, accounting rows and beginning cash for each quarter of the year. The term "beginning cash," seen in a row for each quarter, refers to the cash needed to start the cultivation of that particular quarter. Since many small-scale farmers in Paraguay are apparently returning to traditional practices, or have been exposed to certain technologies that lessen the need for money to purchase insecticides, herbicides and, in most cases, seed, these amounts are generally low. The objective function – in all scenarios tested – is the maximization of end-year cash. In the area where these farms are located a cash economy

has replaced the purely subsistence one quite some time ago, to a greater or lesser degree. The term "End- Year Cash" is different from "Total Income." The latter term describes the total of all in-coming money from sales and other sources. It also usually includes the value of consumed items not purchased. The former refers exclusively to the amount of money left over, after expenses are paid, for discretionary spending, or the purchase of "luxury" items. This means things not strictly indispensable for survival. The year was divided into four quarters to account for cash flow and necessity for crop storage. The first quarter: January, February, March is a somewhat "relaxed" time as far as fieldwork is concerned, as most crops are in a vegetative stage and maize has already grown too high for weeding. This quarter, however, is important because near its end there is an important cash requirement for the purchase of school supplies and uniforms. Second quarter: April, May, June is harvest time. It is here that labor is most constrained. The third quarter: July, August and September is when soil preparation is the main activity. In the fourth quarter: October, November and December, planting and weeding are the main activities and the grocery bill goes up due to the Christmas holidays (this is more true at the site nearer to Asunción, than the site further away).

Inputs

Details of Resources and Constraints

A standard small-scale farm in Paraguay consists of different combinations of the following:

1) Crop field, where maize, cotton, manioc, cowpea and other crops may be planted separately (with occasional intercropping between rows of maize and manioc).

2) Agroforestry plot: Mbocayá palms (*Acrocomia totai*) and intercropped squash, melons and peanuts on ridges. It may also be left as a silovopastoral plot with natural grass under the trees.

3) Wood lot.

4) Fruit trees, citrus, banana and lately, hybrid mango (only at Eusebio Ayala).

5) Yerba Mate (occasionally in an enriched, managed patch of forest with other species).

6) House and yard with medicinal plant garden (home garden).

7) A small parcel of sugar cane and/or Elephant grass (*Pennisetum purpureum*) for cut and carry feed.

8) Fallow.

General Activities

The model is a one-year simulation. The crops to be harvested include cowpeas (*Vigna unguiculata*), maize, peanuts, squash, coconuts (*Acrocomia totai*), manioc (*Manihot esculenta*), and medicinal plants (made up of several species but considered as one crop). Citrus and hybrid mangos are grouped together in the fruit activity column. Cattle, pigs, chickens, and ducks are considered only as consumers of maize and manioc, and their consumption of feed added to the family consumption requirements. Most farmers at both sites bought beef as their principal source of meat. Also, most supplemented their protein requirements with poultry and legumes. The consumption of livestock was reserved for festive occasions, and their sale for episodic needs.

Several activities besides raising crops were built-in. These are a selling activity for each saleable crop product, and a grocery buying activity that goes on monthly. Items

bought in the local stores include first and foremost meat, along with "galleta," a kind of hard-tack biscuit, rice, noodles, tomato paste, powdered milk, cooking oil, kerosene, propane gas, matches, and cigarettes. Off-farm labor was made available for a limited number of days per year for adult and adolescent males. This limit reflects information obtained during interviews regarding the fact that work is not available all year round, and if it were, it would be very difficult to take except during the slack season ("winter").

An additional input to the system is remittance money sent by family members. These can be daughters working as domestic help in the city or sons who have gone to Ciudad del Este or other cities in search of jobs. One man near Eusebio Ayala had four daughters in the United States, all of whom sent money to their grandmother on a monthly basis. From Ñu Pyahú, some of the men go to Argentina in the winter to work in forest plantations. Most farmers noted that while these remittances are well received, they are not counted on for the proper functioning of the household but rather come as a windfall. In the model, this is referred to as daughter's remittances. The young woman, who may typically work as a domestic servant in Asunción contributes nothing of labor, but could send around Gs. 1,800,000 or $643 annually. Sons work in cities in Argentina usually during the off months and may bring home a similar amount (exchange rate: 1 U$D = 2,950 Gs., July, 1998). In the model, additional labor may also be hired during land preparation and harvest periods.

Principal Crops Grown (Cropping Activities)

Maize: Tupí Locro (white flint), Tupí pyta (yellow flint), and Avatí chipá (yellow dent) are grown mostly for family consumption and to feed the poultry and pigs on the farm. In the town of Valenzuela there is a farm which produces certified maize hybrid

seed. However, most farmers interviewed rely on seed saved from the previous season. The Ministry of Agriculture's SENASE, or seed division also produces seed of both selected lines and hybrids. The quality of these is not always reliable and distribution occasionally runs along political lines (especially during election years).

Beans: cowpeas (*Vigna unguiculata*) and some broad beans are generally grown for self-consumption. Often, but not always, they are associated with maize where they are useful for ground cover and for saving on weeding labor.

Manioc (cassava): as in the rest of the country, manioc is the traditional product for family consumption. It is in fact the daily bread. Whatever the family does not consume is sold at the market as fresh manioc. Industrialization to transform manioc into starch is insignificant, even though in the department of La Cordillera there are many "Chipa (Paraguayan scone) factories" which consume large amounts of cassava starch. As much as 176 tons are needed each year (just for chipa) according to a market study undertaken by a firm interested in installing a starch factory in the area (Fretes et al., 1993). The government reported average yield of manioc is 18 tons/ha, except in a very few newly cultivated areas where it can be greater. Since this crop is so traditional, many ancestral methods of cultivation and varieties are used. The manioc growers developed their own science, which was enriched over the centuries. Due to this, most small-scale farmers handle from three to five varieties at the same time, enabling them to provide the "daily bread" almost all year round. There are more than 45 varieties and ecotypes known in the country that differ in taste, size, time to maturity, and resistance to disease and pests (Rovira, pers. comm., 1999). Apparently, in Ñu Pyahú, manioc is more of a staple than in Eusebio Ayala (La Cordillera). It was never absent from the table during

my stay there. In Eusebio Ayala, we sometimes had "galleta or coquitos" a breadstick-like wheat and lard product instead of manioc. I could always see manioc in people's fields, but it was either for sale, or the plots were too small to provide year round.

Peanuts: Traditionally, peanuts are for family consumption; however, recently they are becoming more of a cash crop. As with manioc, a large number of varieties and ecotypes are handled.

Sugar Cane: Many farmers have at least a small plot for cattle fodder during the winter months. In and around the city of Piribebuy there are several molasses factories that consume large amounts of sugar cane. The price however, has become unattractive to farmers recently and they have been replacing it with other crops. Many farmers have gone bankrupt in the past due to the low prices paid by the sugar mills.

Mbocayá nuts: (*Acrocomia totai*). These trees are the best example of components of a traditional silvopastoral and agroforestry system in the region. Many small-scale farmers keep and take care of these trees as they provide cash income around Christmas time, through the sale of their small round nuts. Leaves and other subproducts are used for animal fodder. This activity is more common at Eusebio Ayala than at Ñu Pyahú. Some experts predict the end of the coconut industry with the coming of MERCOSUR (the Free-Trade Common Market of the Southern Cone).

Fruit: Bananas are mostly for household consumption. Citrus and a newer crop, hybrid mangos are cash crops at Eusebio Ayala, while at Ñu Pyahú they are mostly for household consumption. Fruit often face unfair competition from Brazilian contraband.

Squash, melons, and watermelons: are traditional spring/summer crops and useful as groundcover while intercropping. Melons and watermelons are used in the same way.

These are grown mostly for consumption although they may be sold if prices are good.

Medicinal plants: many small-scale farmers have a small garden for family consumption, which saves on formal medical treatment. Due to the large population in Asunción, and other cities, where consumption of medicinal plants is as high as in the countryside, some plants have become limited cash crops for farmers in La Cordillera department. The garden can range from just pots around the house to vegetable type gardens, and even multi-strata agroforestry gardens containing trees, bushes and herbs. Only two persons who grew medicinal plants as their only cash crop were found during recent research in La Cordillera department. Gathering these plants is a common activity, but it was not included in the ELP, due to the fact that cultivation was the primary objective of this thesis.

Because the technology that was specifically to be tested in this thesis was the production of medicinal plants, details regarding their production were sought. Precise data on this crop was more difficult to obtain than for the others listed above. Baseline data used were obtained through surveys, and on-farm interviews. Although most farmers did not have hard numbers regarding these plants, there were two women who provided me with enough information on production costs, yields, and prices to enable the LP to incorporate this crop with a sufficient degree of accuracy.

This is a horticultural specialty crop. However, as there are many species in demand on the Paraguayan market, a farmer would most likely be better off by offering a range of them. There is an internal market in Paraguay for medicinal plants of approximately thirty million dollars per annum. "Medicinal plants," refers here to the growing of several species in a home garden context. The fact that the crop consists of

several species which may include plants whose bark, roots, tubers, leaves, stems, flowers, fruits or seed are the portion that is marketable, does not detract from it being considered one specialty crop. A study conducted in the area of Pasto, Colombia compared specialized to unspecialized crop farmers. Among the conclusions was, "to be specialized does not mean that a farm can produce only one crop a year, such as wheat, in our study area. Nor does it mean only one crop each semester (either the same or a different crop). A few different but similar vegetables, for instance, could probably be raised by one farmer "specialized" in vegetables without his being affected by uneconomic enterprise combinations (Hildebrand and Luna, 1973)." Based on these premises, the farmers we will identify will be "specialists" in medicinal plants, without detracting from their ability to provide food for themselves except perhaps for the case of certain very small farms.

The only wholesale unit of measurement for medicinal plants on the production side found during research was the "bolsa." This is a standard 80-liter plastic burlap (sugar or flour) bag. In most cases, the bag contains several species that are separated once they reach the market. One ha of medicinal plants produces approximately 600 bolsas per year. Production is concentrated in spring and fall with a drop in summer and an even greater dip during winter. In spite of these variations, medicinal plants can be produced all year round. Under the current marketing system for gathered plants, women take a basket load of herbs to a middleman who pays Gs. 500 for each dozen "mazos" (bundles). The intermediary sells the mazos at three for Gs. 500. The mark-up from gatherer/producer to final consumer through the middleman is 400%. The only persons

found who dedicated 100% of their land and time to the production of medicinal plants were selling each bolsa for between Gs. 30,000-50,000 every other day at market.

Livestock: livestock in general and cattle in particular are considered a sort of savings account as well as providers of traction on the farm. Management is done in small paddocks, in silvopastoral (with coconut), tethered on roadsides, and on the stubble of harvested crop. The area utilized is generally small and overgrazed. In the past, common grazing areas were very much in use, and roadside use is still common. At present, farmers who possess cattle tend to grow cut and carry forage at Eusebio Ayala, such as elephant grass (*Pennisetum purpureum*) and sugar cane. Some families own two oxen, while others may rent from them during soil preparation time. These renters do not always have the benefit of preparing their land at the opportune moment, as the owners of bullocks will prepare their own land first, and then put their draft animals up for rent. Cattle were not considered in the ELP because it is a one-year model. A multi-year model is required to analyze the fluctuating population of a herd or flock due to births, deaths, and sales. All livestock however, are considered in the model by adding their consumption needs (except for grass) to those of the family.

Pigs and Poultry: at both sites, these are raised mostly for consumption. They are rarely sold except in cases of extreme need or when surplus is available. A family may own two mother sows and twelve piglets of different sizes. Boars of "improved quality" are usually available from neighbors for a small fee to cover the sows when they are in heat. These will be considered in the LP only as consumers. Their consumption of maize and manioc is added to that of the family on the right hand side of the LP.

At Ñu Pyahú, livestock were varied both in type and number. All houses had chickens and ducks. Some had pigs and a few had sheep. There was usually one horse per household. One farmer, who had become a middleman during the cotton boom which lasted from 1970 until 1990, had made enough money to own a small heard of beef cattle (60 head), he is however an outlyer and was not factored in with the other producers. The livestock mix used in the models was two cattle, three pigs, and 16 chickens and ducks.

Table 11. Reported Yields and Farmgate Sales Prices for Certain Crops at the Study Sites

Crop	Average Reported Yield	Unit	Farmgate Prices in Gs. August, 1999
Maize (Tupí)	1,700	kg	150
Maize (Chipá)	1,200	kg	900
Maize (Locro)	1,500	kg	900
Cowpea	850	kg	1,200
Manioc	18,000	kg	180
Squash	1,300	kg	170
Peanut	800	kg	1,100
Cotton	800	kg	730
Coconut	20	Crates	3,000
Oranges	38,00	100 Fruit	5,000
Tangerines	45,000	100 Fruit	3,600
Lemon	50,000	100 Fruit	3,400
Banana	200	Bunches	1,000
Hybrid Mango	25,000	100 Fruit	3,000

Source: Interviews with farmers in July 1999 and Ministry of Agriculture Statistics.
Exchange rate: I U$D = Gs. 3,300.

Resources

Land

Besides labor, the other major resource the farmers have to work with is land (capital is almost always scarce). Questions were asked of the farmers at both communities regarding their land. This included number of plots owned, and the size of these, tenure, and types of land that made up the plots.

Most farmers had one plot of land. A smaller number possessed two. Some farmers approaching middle age worked on their father's land and did not have any of their own. The average farm size was 13.7 ha at Ñu Pyahú, and 3.2 at La Cordillera. Many farmers at Eusebio Ayala, La Cordillera had less than one hectare. The average is skewed upwards by a few farmers who owned larger plots. As far as types of land, all farmers had the major portion of their fields on flat or gently sloping land. They also possessed smaller crop fields on hillsides. Pasture, fallow, and marshy land made up the remainder of most farms. Those at Ñu Pyahú had larger fallows and fields, as well as more grazing land. Farmers at Eusebio Ayala often had no grazing land or fallow. However, they usually had more land planted to fruit than those at Ñu Pyahú did. These data were used in the design of the ELP model. Disaggregating land into arable and other land uses permits a closer simulation of reality. The amount of land truly available for farming was used in the model. Detailed answer to questions regarding land may be found in Appendix A.

Labor

Adult Male: The principal male or father does most of the heavy fieldwork. This includes plowing, weeding, raising ridges, spraying, etc. The single most important tool on the farm is the hoe, followed by the ever-present machete. The presence of the woman during these cultural labors is noteworthy as she is often hauling water and cooking food so that the work does not suffer too many interruptions. Women also do much more weeding when cotton is the crop. The number of days required for labor on each crop can be seen in Appendix A. At Ñu Pyahú, an exception was found. Delia, a 16-year-old girl was known as champion plower. While most others took four days to plow one hectare, Delia could do it in three and a half. Her parents were extremely proud of this fact. Off-farm work is an option in times of need or at certain times of year. For the principal male, this is more common at Eusebio Ayala than at Ñu Pyahú.

The housewife does much work that is difficult to account for. Luckily, La Cordillera Department is close enough to Asunción so that she can use bottled natural gas for cooking, and although this is not the general rule for all of rural Paraguay, it does save quite a bit of time on not having to gather firewood on a daily basis. The negative side of this, of course, is that each 10-kg tank of gas sells for Gs 16,000, and it is difficult to use less than two tanks per month. At Ñu Pyahú, on the other hand, firewood must be gathered. Some time is spent each day drawing water from the well. This water is taken to the house in plastic buckets about 15 liters at a time. Water is also hauled to the pigs and chickens. Additionally, several bucketfuls per day are carried to the medicinal herb garden. The time needed for this activity was slightly less at Eusebio Ayala than at Ñu Pyahú, as 78% of homes had a well as one of their sources of water, while 30% of the

total also had running water. At Ñu Pyahú, although 81% of homes interviewed had their own well, none had running water. A detailed list of water sources at both sites can be seen in table12.

Table 12. Water Source for 45 Homes at the Study Sites

Source	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Well	8	35	18	81
Well with running water	2	9	0	0
Well and spring	7	30	0	0
Spring	1	4	3	14
Rural water company	4	17	0	0
Well and rural water company	1	4	0	0
Stream	0	0	1	5

Eusebio Ayala and Ñu Pyahú Paraguay, July 1999. N= 23 at E.A., N=22 at Ñ.P

A good portion of the day is consumed by household chores, especially sweeping, washing clothes and dishes, and caring for small children. All this leaves the mother with limited time for fieldwork. This varies tremendously however, and while some young mothers engage in much field-work, other relatively well-off ones with several teen-aged boys can have the luxury of staying at the house and not working in the field at all, except for the harvest and post-harvest. She always participates at planting and harvesting time, and when the husband may need a hand, such as hauling water to him when he is fumigating, or when there is an extra strong weed infestation that requires urgent attention. The actual seven-hour days that the mother has left over for working in the fields varies greatly with the amount of small children she has to care for.

Teen-aged boys, if they attend school, work only about one hour per day doing mostly chores. On average, each adolescent is only able to contribute 20 to 26 seven-hour workdays per year including extra time put in during harvest. Those who do not

attend school or have an absent father, put in many more hours in the field, and bear the brunt of the labor. In this case they can contribute up to 80 days of labor per year.

Teen-aged girls first and foremost help their mothers in all her activities. They do more fieldwork, however, once they have reached the age when they can handle a hoe well. They are especially important in childcare, weeding, harvest, post-harvest and preparation of produce for sale. Teenagers are often involved with selling activities, accompanying the mothers to market, as is the case of medicinal plants in the Cordillera Department. Girls at Eusebio Ayala work less in the field than those at Ñu Pyahú. The amount of work they do in the field varies tremendously from family to family.

Children, when very small are a draw on mothers' and sisters' time as they need care. When they are around six or seven they are of some help feeding animals around the house, hauling food and water to older siblings and parents working in the fields, and at harvest and storage time. Because of school, they have little time available for actual fieldwork. When cotton is the main crop however, children often skip school. The work is hard and hazardous (due to pesticide residue).

Table 13. Summary of Labor Generally Available per Year at the Sites

Family Member	Days Available
Adult male:	280
Adult female:	140
Teen-aged boys:	80*
Teen-aged girls:	60
Children:	40

Source: Surveys conducted with Paraguayan farmers during July-August, 1999.
* If school is not attended.

The labor required for the production of crops is constrained by the availability of each family member by gender and age group, and also by season. The calendar is divided into four quarters. Since most children attend school from March through November, it is easy to see how their absence for the greater part of the day can be felt in the second and third quarters. The table below shows the work generally required for producing each of the crops included as activities in the LP.

Table 14. Reported Labor Requirements for Crops by Quarters per ha per Year

		Maize	Manioc	Intercrop *	Cotton	Cowpea	Medicinal Plants**
	Quarter	Person-days	Person-days	Person-days	Person-days	Person-days	Person-days
Adult Male	First Quarter	3	3	4	9	0	0
	Second Quarter	5	8	6	14	12	0
	Third Quarter	6	6	4	12	3	0
	Fourth Quarter	5	6	2	10	6	0
Adult Female	First Quarter	0	0	0	8	0	10
	Second Quarter	3	3	6	14	4	10
	Third Quarter	1	3	0	8	5	10
	Fourth Quarter	2	3	0	6	6	10
Teen Boys	First Quarter	0	2	0	2	0	6
	Second Quarter	2	0	2	4	4	8
	Third Quarter	2	2	2	4	0	2
	Fourth Quarter	0	2	2	2	2	8
Teen Girls	First Quarter	0	1	0	2	0	6
	Second Quarter	2	3	2	4	4	6
	Third Quarter	2	1	2	4	0	6
	Fourth Quarter	0	1	2	2	2	6
Kids	First Quarter	0	0	0	2	0	6
	Second Quarter	1	1	1	2	2	6
	Third Quarter	0	1	1	4	0	6
	Fourth Quarter	0	1	1	2	0	6

Source: Surveys conducted at Eusebio Ayala and Ñu Pyahú, July-August, 1999.
* Peanut, squash, coconut, melon
** Does not include labor for selling

While total labor is not a constraint for a family of eight able-bodied members, when broken into gender and seasons (quarters) it is clear that adult female labor is constraining at times, as well as adolescent male labor (when school is attended). Adult male labor is also a limiting factor, especially during the third quarter – or planting season, and the second quarter – or harvest season. Seasonal constraints to production can be seen in the LP matrix in Appendix D. Labor is fungible to a point. That is, a father can take over some of the hoeing when a son is briefly away. This however is limited to the physical possibilities of the adult and the size of the field being considered. A woman and teen-aged girl can trade child caring responsibilities. Other labor activities are usually not fungible, such as bundling medicinal plants and gathering manioc roots, which are considered women's work. This type of division is generally by gender.

The Intercrop Numbers

The tables and person-hours listed above correspond to each crop cultivated separately. Upon deeper inquiry, it was found that some crops in this area are intercropped in fields that are sparsely populated by the Paraguayan coconut palm. Maize is the principal crop, planted about one meter apart – sometimes more – allowing for the intermediate rows of cassava, cowpeas, squash or peanuts. The following table was set up for this intercrop:

Table 15. Reported Person days Required for the Intercrop per ha per Year

Person	Days per year (coconut, maize, peanut, squash, beans)
Adult Male	18
Adult Female	10
Teen Boys	6
Teen Girls	4
Kids Labor	3
Total	41

Source: Surveys conducted at Eusebio Ayala and Ñu Pyahú, July-August, 1999.

Table 16. Labor Required by Quarter for Intercropping Peanuts, Melons, Squash, and Coconuts per ha per Year

	Quarter	Intercrop*
Adult Male	First Quarter	4
	Second Quarter	6
	Third Quarter	4
	Fourth Quarter	4
Adult Female	First Quarter	0
	Second Quarter	6
	Third Quarter	4
	Fourth Quarter	0
Teen Boys	First Quarter	0
	Second Quarter	2
	Third Quarter	2
	Fourth Quarter	2
Teen Girls	First Quarter	0
	Second Quarter	2
	Third Quarter	2
	Fourth Quarter	0
Kids	First Quarter	0
	Second Quarter	1
	Third Quarter	1
	Fourth Quarter	1

Source: Surveys conducted at Eusebio Ayala and Ñu Pyahú, July-August, 1999.

The number of days required for crop work has been drastically reduced, not by half, but by three-quarters, when contrasted to a hectare of a monocrop. Although this information appeared dubious at first, it was later confirmed from separate sources. Intercropping then is much more than an environmentally better way of growing things that small-scale farmers use seeking the benefits of pest control, improved fertility and crop complementarity, it is actually a great laborsaving device known and passed down for countless generations. If during one walk to the same field a farmer can perform several separate operations such as planting one crop, thinning another and weeding still another, the total amount of time saved – although the total work may be the same – is enormous. A detailed listing of workdays required per activity for each crop can be found in Appendix A.

Constraints

Anything that limits the ability of the farmer to survive and thrive (reproduce) is called a constraint. These are included in the right hand side of the model as limiting factors. The principal constraints are the amount of *arable land* a farmer possesses, the amount of labor his or her family can provide, food requirements, and cash needs. Limiting factors of the soil and cultural practices are reflected in the yields. The constraints on labor and land are described above in the resource section. Cash needs are described below.

Cash Needs

As in most agricultural systems around the world – even in some of the most remote areas – cash is a needed input for the system to function. As described in Chapter 1 of this study, all farm communities in Paraguay have been exposed to the market

economy for quite some time. This was accentuated by the dependence on cotton as the sole source of income during the 1970s and 80s. Items that may have been regarded as luxuries in the past are now considered to be normal needs. These may include jeans, shirts and tennis shoes as well as soft drinks, minor electronics and other personal items. However, when we talk of cash needs for the LP model, we are referring to the cash needed at the start of each cropping season, or to begin each activity. These are included as constraints called "beginning cash." To add to this, some basic groceries are bought on a monthly basis. These needs are shown in the columns labeled grocery buying activity and are divided by calendar quarters.

In La Cordillera department most farmers tended toward cash crops and bought or bartered for many things they did not produce. Food security nevertheless, was seen as an important issue as everyone grew manioc, maize, and beans at both sites.

With regard to food consumed, a great deal of stew based on noodles and rice is eaten along with the more traditional foods. This is true of Ñu Pyahú as well as of Eusebio Ayala. One way of showing insertion into the market economy is by how often rice and pasta dishes are consumed. These require cash to buy. It is well documented that cooking this type of food requires much less elaboration time on the part of the woman. Therefore, it is difficult to discriminate if this "modern" consumption is a laborsaving device, the result of globalization or merely an acquired taste. As far as variety, most interviewees responded that their basic foods vary little within the year, except for those short periods when certain items such as new manioc or fresh corn may not be available.

Table 17. Yearly Cash Requirements for Specific Needs by Farm Families at Eusebio Ayala and Ñu Pyahú

Activity	Guaraníes
To begin land preparation for	
All crops raised in the normal season	
i.e. maize, beans, squash, manioc	420,000
For pesticides and seed	140,000
Fuel (bottled liquid propane)	300,000
For hired help in the field	200,000
To hire help for the harvest	150,000
To go to the market and sell products	340,000
To buy school uniforms and supplies	85,000
To pay for medical appointments	
or treatment at:	
The local pharmacy	80,000
The Health Center	52,000
Private medical office	32,000
At the hospital	45,000
With a traditional healer	28,000
For Christmas and New Years	100,000
For Easter week	120,000
For birthdays and other celebrations	77,000

Exchange rate: 1US$ = 3,300 Gs. July, 1999.
Source: Surveys conducted at Eusebio Ayala and Ñu Pyahú, July-August, 1999.

Questions were also asked regarding cash needs and handling (who makes the decision to spend cash) during the survey. The results may be found in Appendix A.

Credit

Credit was not included *per se* in the ELP. Interest costs are implicit in the high prices payed by farmers for everyday items at stores run by middlemen. It is difficult for any farming system in modern times to thrive without institutionalized credit. However, since the demise of the cotton boom, resource-limited farmers have been shying away from using it. There are very few government-run credit programs, and even these use commercial lending rates (24-48%). This is one of the issues that merits urgent and intense additional research. Credit for marketing (see Chapter 7) is as scarce as that needed for production.

Conclusion

The above information obtained from farmers was used for the purpose of constructing the base linear program. No typical or average farmer or household was found or known to exist. The diversity among households at each site and between sites will be brought out as different scenarios are tested in the following chapter. The LP seeks to identify which families living at which location would be the most likely to adopt the practice of planting and marketing medicinal plants. It is expected that the cultivation of medicinal plants, heretofore a suspected survival strategy and cultural phenomenon, will broaden the livelihood system and add an additional livelihood strategy to provide certain campesino families with cash to participate – when desired and needed – in the market economy.

In Chapter 6, outputs from the farm expressed as results of different scenarios tested will be discussed. It is expected that different family compositions, different farm sizes and different distances to the market will be important variables for the model. If these variables have been captured to a high degree of reality in the descriptive phase of LP design, reliable predictions can be expected. Analysis of research questions regarding strategies and being "better off" and other aspects of the livelihood system will be sought by testing several alternatives in the same ethnographic linear program.

CHAPTER 6
OUTPUTS FROM THE ETHNOGRAPHIC LINEAR PROGRAM

Introduction

"Any model represents a simplification of reality. Simplification involves assumptions, which in effect are hypotheses as to the structure and function of the unit under study. The validity of these assumptions and the potential of the conceptual framework can be evaluated by applying the model to reality and analyzing the results (Hart, 1979)."

Accurate modeling of a complex small farm requires the researcher to go into the field and gather ethnographic as well as production data *in situ*. The model is later formulated, and in order to validate it, he or she may go back to the field and test it on farmers with similar resources and constraints. By honing and fine-tuning the model, one can come to a very approximate simulation of reality. This accuracy allows us to pre-test new technologies on systems.

The baseline LP used in this thesis was validated using a simple method. Resources, constraints and activities of a known farm were used to form a matrix for the optimization model. Once the model was running with all the known factors in place, the unknown factors could be tested by a method of trial and error in attempts to make the model look as much as possible like the real farm. Using this type of induction, yield was looked at specifically as a source of error in modeling. In effect, the use of research station or government statistic yields led to constant errors in the amount of land farmed.

With yields much higher than ordinarily anticipated by farmers for planning, a small plot of land sufficed to feed the family and leave substantial amounts of discretionary cash at year's end. Halving the yields, and then reducing them even more, allowed a closer replica of the known farm formulated using the Quattro Pro spreadsheet. Farmers' anticipated yields (for planning area to plant to a basic crop) are very often much lower than averages indicate. A graphic representation of these ranges can be seen in Figure 2 below.

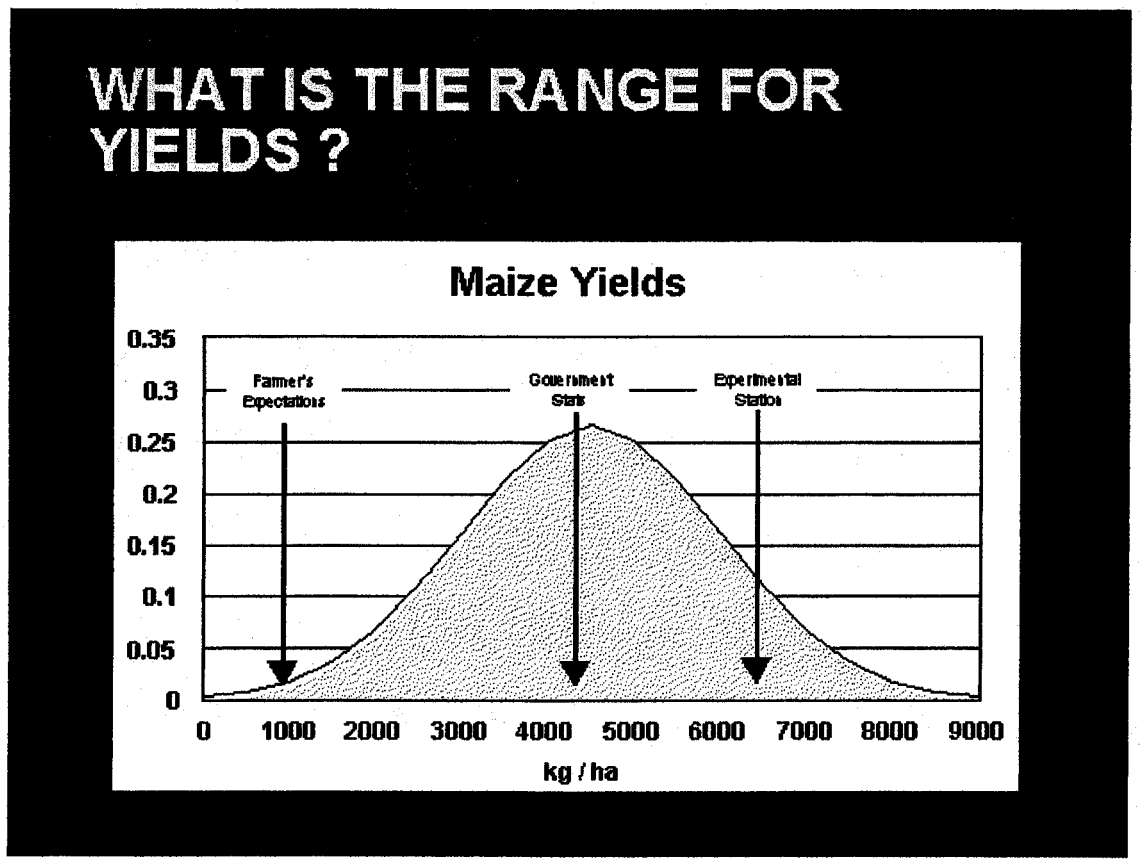


Figure 2. Farmers' Anticipated Yields for Planning

Table 18. Model Calibration Using Lower Yields

Yields Tested (kg/ha)			
Maize	**Manioc**	**Hectares**	**Description**
6,500	25,000	0.34	Research Station Reports
4,500	18,000	0.67	Government Statistics
2,250	9,000	0.82	Halved
1,125	4,500	1.37	Halved
900	3,800	1.42	1.44= real value

Source: Merardo Franco's farm in Fretes et al., 1993 was used for validation purposes.

Land and Discretionary Cash

This test was run to show how cash available at the end of the year for discretionary spending varies with different amounts of land under cultivation. The amounts also vary from the cotton boom period to the present. Although absolute income from medicinal plant sales is not great, the incorporation of medicinal plants into the farming system could increase discretionary cash up to 300%. Results can be seen in the following table. Specialty crops are more stable than cotton under small farm conditions.

Table 19. Size of Arable Land and Its Effect on Discretionary Cash

Land (ha)	Discretionary Cash (Gs.)		
	Cotton Boom	**Present (without medicinal plants)**	**Present (with medicinal plants)**
0.50	1,588,000	1,182,000	2,823,000
0.39	1,260,000	1,035,000	2,808,000
0.34	1,111,000	968,000	2,801,000

Source: ELP. See Appendix D.

Remittances and Food Security

Varying amounts of remittances from family members were used to determine the effect on the overall function of the farm. These remittances improved the amount of cash available at the end of the year for discretionary spending. However, even at the level of zero remittances, the amount of discretionary cash was only reduced by around 20 %.

Table 20. Amount of Remittances from Family Members and their Effect on End-Year (Discretionary Cash)

Remittance	End-Year Cash
1,800,000	2,451,000
1,200,000	2,301,000
600,000	2,151,000
400,000	2,096,000
200,000	2,051,000
0	2,051,000

Source: ELP. See Appendix D.

End-year cash does not vary when remittances are received in different quarters. The results demonstrate that the system does not rely on remittances to function. The farmer most likely considers them a windfall.

Price Threshold at Which Medicinal Plants Replace Cotton

Two tests were run on the linear program regarding the point where farmers would replace cotton with medicinal plants as a cash crop. Table one shows the results of increasing price per bag of medicinal plants with the price of cotton fixed at Gs. 2,000. This was considered a very good price for cotton. Medicinal plants must reach a market price of Gs. 100,000 in order for farmers to replace the portion of their income from cotton with the new crop – medicinal plants. This situation was real during the 1980s.

Table two shows a similar procedure. The price of medicinal plants was fixed at Gs. 50,000 – a real figure for 1999. The price of cotton was lowered by units of Gs. 250 until at a price of Gs. 1,200 per kg; the model stops planting cotton and switches to medicinal plants. It is interesting to note that the model never chose a mix of cotton and medicinal plants. This either/or behavior is likely due to the labor constraints of both crops, especially on women (the average price of cotton for the period 1995-1999 was Gs. 1,045). It is mathematically due to the fact that the model is linear.

Table 21. Point at which Medicinal Plants Replace Cotton when Cotton Price is Fixed at Gs. 2,000/kg (Early 1980s Scenario)

Price of Medicinal Plants (Gs.)	ha Planted to Medicinal Plants	ha Planted to Cotton
25,000	0	0,47
50,000	0	0,47
100,000	0.012	0

Source: ELP. See Appendix D.

Table 22. Point at which Medicinal Plants Replace Cotton when Medicinal Plant Price is Fixed at Gs. 50,000/bag (1999 Scenario)

Price of Cotton (Gs.)	ha Planted to Medicinal Plants	ha Planted to Cotton
1,500	0	0.47
1,250	0	0.32
1,200	0.09	0

Source: ELP. See Appendix D.

Being Better Off

To test the hypothesis that those who balance market demands with household security needs are better off, "shocks," or unforeseen healthcare costs were introduced into each one of the quarters of the production calendar. Results suggest that if people did not rely on medicinal plants for a more balanced diet and health status, more frequent shocks would make their farming systems infeasible. Incidental costs are felt most in the first and second quarter. This is due to the fact that money from sales of the major harvest crops comes in during the beginning of the third quarter and lasts through the fourth.

Table 23. Response of the System to Healthcare Expenditure Shocks in Different Quarters of the Year Expressed as Variations in End-Year Cash

Sudden Healthcare Expenditure 1st Quarter (Gs.)	Sudden Healthcare Expenditure 2nd Quarter (Gs.)	Sudden Healthcare Expenditure 3rd Quarter (Gs.)	Sudden Healthcare Expenditure 4th Quarter (Gs.)	Solution Expressed as End-Year Cash (Gs.)
1,000,000	1,000,000	1,000,000	1,000,000	1,451,000
1,500,000	1,500,000	1,500,000	1,500,000	951,000
1,700,000				698,000
	1,700,000	1,700,000	1,700,000	751,000
1,750,000				Infeasible
	1,800,000	1,800,000	1,800,000	651,000
	2,000,000	2,000,000	2,000,000	451,000
	2,100,000	2,100,000	2,100,000	304,000
	2,150,000			Infeasible
		2,300,000	2,300,000	151,000
		2,400,000		Infeasible
			2,400,000	51,000
			2,500,000	Infeasible

Source: ELP. See Appendix D.

Likely Adopters

Both household composition and distance to market were used as variables to identify potential adopters. Distance to market was captured in the "sell medicinal plant" activity of the matrix. Women from Ñu Pyahú require more than twice the time it takes for women at Eusebio Ayala to make the round trip to market and sell their medicinal plants. This severely limits their ability to market fresh produce. The family compositions tested for each of the sites were the following:

Table 24. Scenarios Tested in Determining the Effect of Household Compositions on the Likelihood of Adoption of the Cultivation of Medicinal Plants

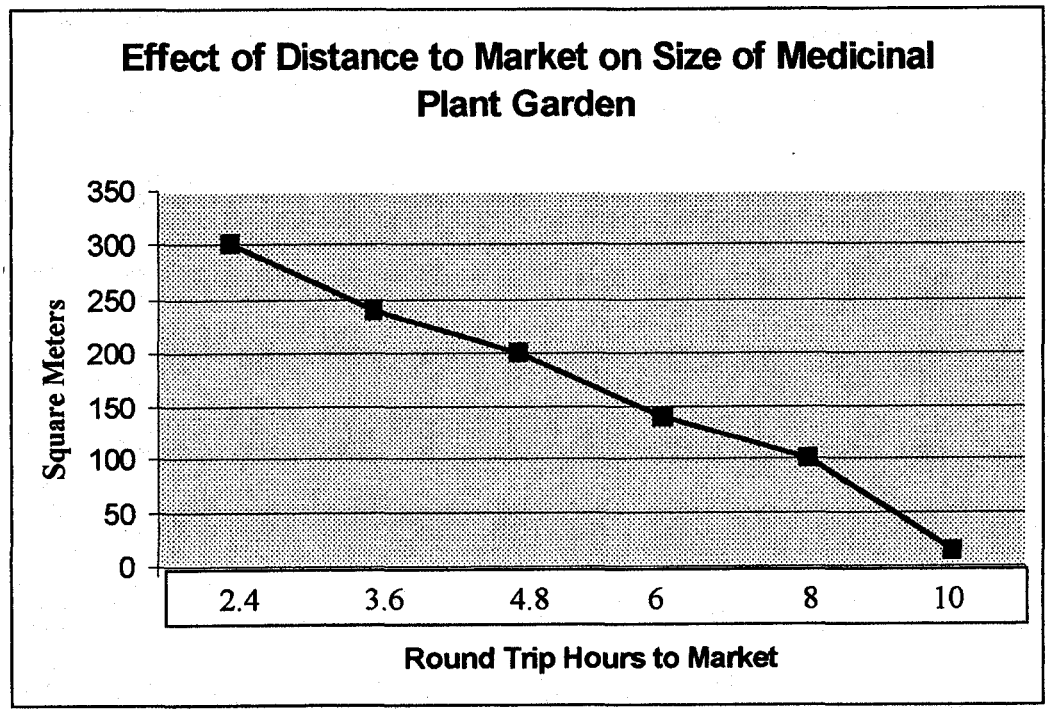
Household	A	B	C
Adult Male	1	1	1
Adult Female	1	1	1
Adolescent Male	0	0	0
Adolescent Female	0	0	2
Children < 12	0	3	3

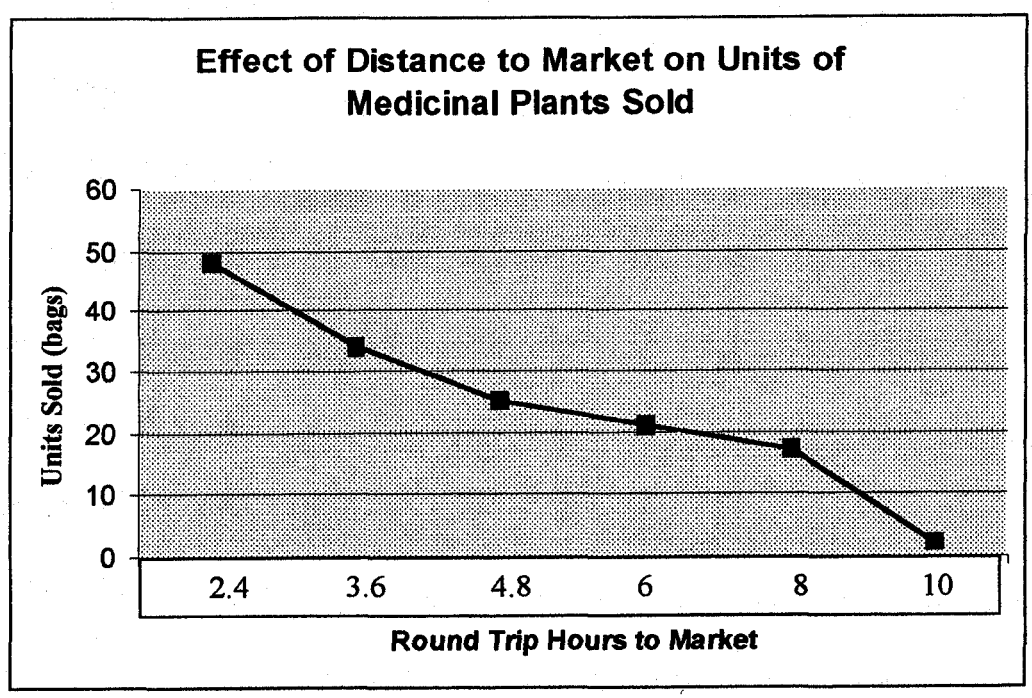
Source: See Appendix D.

At Eusebio Ayala, 80 km from the main market, three family compositions were tested to see their response as possible target households for medicinal plant cultivation extension projects.

Household A (see description above) cultivated 0.012 ha of medicinal plants. Household B cultivated no medicinal plants. Household C cultivated 0.012 ha of medicinal plants, the same amount as Household A.

At Ñu Pyahú, 250 km from the main market, the same family compositions were tested. Families A and B did not grow medicinal plants. Although Household C grew a small plot of medicinal plants, the amount was negligible (6 m^2). It can be concluded that no family this far from the market should be targeted as potential medicinal plant producers under current conditions.


Effect of Distance to Market on Size of Medicinal Plant Garden
Square Meters
350
300
250
200
150
100
50
0
2.4
3.6
4.8
6
8
10
Round Trip Hours to Market


Effect of Distance to Market on Units of Medicinal Plants Sold
Units Sold (bags)
60
50
40
30
20
10
0
2.4
3.6
4.8
6
8
10
Round Trip Hours to Market

Conclusion

An ethnographic linear program model can be used to analyze many aspects of a farming system. Several tests were run on the LP model. These included 1) a model calibration test using data from a known farm as a benchmark 2) how the amount of land in cultivation affects end-year cash 3) how remittances affect end-year cash 4) the cut-off point or threshold sales price at which medicinal plants replace cotton as a cash crop 5) how unexpected healthcare expenditures affect the system in different quarters of the year, and 6) which type of households would be most likely to adopt the cultivation of medicinal plants as a cash crop.

Interesting conclusions were reached from all tests. However, the most pertinent to government or non-government agencies planning on setting up medicinal plant projects pertain to point 6. These are the following:

A- Only households located near enough to the main market of Asunción can engage in the activity of growing and selling fresh raw medicinal plants as they have to be taken to market on a daily basis.

B- Selling – more than cultivating – medicinal plants is an activity that falls exclusively within the domain of women. Therefore, families with no principal female and no teenaged females cannot engage in this activity.

C- If there are teenaged girls and small children, the household can still engage in this activity, because the activity of caring for small children is fungible (interchangeable) between mothers and teenaged girls.

D- Households with no teenaged girls but with small children cannot participate successfully in this activity because the mother is severely constrained by the time required for childcare. The eight to ten-hour trip to the market and back only becomes feasible when children become adolescents or older sisters or a member of the extended family is available to care for small children.

E- At the site further from Asunción, different household compositions choose subsistent crops rather than medicinal plants (except for a very small sale from Type C households). This is due to a marketing constraint rather than household composition.

Another conclusion worth mentioning was reached using trial and error for crop yields. The matrix only began looking like the real farm when government statistics for average yields were halved and then halved again. This served to substantiate the notion that small-scale farmers tend to anticipate a lot less from their fields than most government researchers take into account. An additional explanation for low yields is that intercropping often goes unreported. Swaths of land from 3-5 meters wide are plowed in alternate strips, with much loss of land to ridges, coconut trees, termite hills and other obstacles. In other words, a resource-limited Paraguayan farmer who usually plants only 12,000-15,000 maize plants per ha (recommended: 45,000-55,000) usually winds up with only half or less, as he or she is not really using the entire hectare.

As far as cash is concerned, it is not a constraint on the system. This is proved by the fact that the program continues to be feasible even without remittances from a daughter. In these cases, end-year cash is reduced but does not disappear. As greater awareness of the consumer economy exposes the family to new "necessities" such as electronics, appliances, nicer clothes and tennis shoes, etc., a greater strain on the cash

flow can be expected and will surely become a constraining factor before land does. Unexpected healthcare expenses can however, strain the system. This is especially true in the first half of the year when cash flow is limited.

In the final chapter, further conclusions and recommendations will be given. A summary of the thesis will allow these conclusions to be regarded in context.

CHAPTER 7
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Much data was gathered through forty-three completed survey questionnaires dealing with medicinal plants, and eleven in-depth interviews on farming systems. Among them are historical, geographical, nutritional, climatic, and cultural reasons for the extensive use of medicinal plants in Paraguay. Other data gathered include attitudes towards conservation, important healthcare expenditure data, as well as principal ailments and their treatment with certain medicinal plants or in combination with manufactured pharmaceuticals. Farming systems information updated and valid for the post-cotton boom period at the two sites includes labor required for specific crops such as maize, cowpea, manioc, squash and melons, cotton, peanut, and medicinal plants. Similarly, labor requirements for perennial crops such as elephant grass, citrus, mango, yerba mate (*Ilex paraguariensis*), mbocayá nut (*Acrocomia totai*) and sugar cane was elicited directly from farmers. Details regarding farm size land tenure, and land uses were gathered. A fundamental requirement for the correct functioning of the mathematical model constructed was the data obtained regarding cash needs. This included cash for agricultural activities, for school uniforms and equipment, for leisure and groceries. Other sources of income were sounded out including remittances from family members

products to markets, time spent on cooking, cleaning, feeding animals, washing clothes, and caring for children were answered. Data referring to quality of diet were obtained as well as further agricultural specifics such as yields and farmgate prices.

A rapid survey was undertaken with Paraguayan physicians to determine their attitudes towards the use of medicinal plants. A literature review of socioeconomic conditions in Paraguay was included to help orient the reader and to shed light on a little known country. A literature review of the history of medicinal plant use in Paraguay was also included for its importance to Latin American studies, and the history of medicine. Information available in the chapter that refers to this point is essential for grasping the unique and anomalous situation in which Paraguay has existed throughout its history. The complex relationship between medicinal plants, conservation, and development were explored with the explicit intent of highlighting the importance and urgency of starting medicinal plant projects the world over, and particularly in Paraguay.

Conclusions

The literature review has attempted to describe some important aspects regarding medicinal plants. They are important for healthcare, conservation, cultural identity, community and economic development, to mention but a few. With this in mind, it is almost redundant to conclude that any approach to the subject of medicinal plants must be as holistic as possible. If we were to reduce ourselves to the goals of purely economic botany, especially in the light of late 20th century market-dominated thought, we would be running the risk of overlooking the many aspects that medicinal plants play in different contexts the world over. The title of this thesis "The Role of Medicinal Plants

in Rural Paraguayan Livelihoods" is in itself descriptive of one aspect of the whole that could easily escape a direct production-oriented approach.

Ethnographic research by its very nature tends to produce descriptive, narrative results. Modern, materialistic thought however has impressed the need for quantification and reduction of results and their translation into numbers. Researchers such as H. Russell Bernard (1995) have done a very good job in creating a methodology to this effect. I have limited myself to using percentages in my survey results, so as not to fall into the trap of glossing over and masking reality with the curves of a science that was invented for gambling. We should not gamble with human livelihoods. On the fallacies of statistics Robert Chambers points out:

> Let us start conventionally, with statistics. These are notoriously flawed and liable to mislead. The multiple and diverse realities of poverty and well being defy capture by standard measures. Reported improvements or declines can be fictions. Yet, for all their limitations, conventional figures can at least suggest some orders of magnitude, trends, and contrasts. But any complacency would mislead: growth deficits remain; achievements are unstable and need to be maintained; as populations rise, absolute numbers deprived can rise even when averages improve; and depravations interlock, making it harder at the margin to help those who are badly off. (p. 5, 1997)

By looking back at the questions that guided this research, I will attempt to set forth conclusions based on the answers obtained in my surveys, the many hours of personal interviews I conducted at both sites, and analytical results from the ELP. After describing these conclusions, several recommendations will be proffered in the hope that some useful guidelines may emerge from this study.

Strategy

The first question asks if the maintenance of knowledge on the use, gathering and cultivation of medicinal plants is a strategy for balancing household healthcare needs with market demands. In order to answer this question, the term strategy must first be conceptualized. Bernard refers to strategies as decisions that are made to meet objectives, influenced by culture, and household needs and goals (1995). In the strict economic sense, one could assure beyond a reasonable doubt that the use of medicinal plants is a survival strategy if those with lesser incomes have higher rates of use than those with higher income. This is not the case at the two sites that were studied. Rates of use approached 100% at both sites. When asked why they consume medicinal plants a high percentage at both sites mentioned other reasons for using medicinal plants rather than for saving money. This included 48% because of tradition and custom and 39% because they are healthy at Eusebio Ayala and 23% because of tradition and custom as well as 54% because they taste good at Ñu Pyahú (see Appendix A). As a comparative reference point, Favitsky (1997) found that 35% of her interviewees at Piribebuy used medicinal plants to cure or alleviate ailments, 33% used them because they were abundant and accessible, and 33% used them as preventatives to "clean" the organism and for general well-being (as adaptogens[6]). Interestingly, 100% of people interviewed in Favitsky's study consumed medicinal plants on a daily basis. This seems to indicate that the use of medicinal plants is not an economic survival strategy *stricto sensu*. It may be defined as a culturally embedded, multi-objective activity. The distinction between a strategy *per se* and a culturally based activity becomes blurry when one considers that

[6] Adaptogen: a natural non-toxic substance that tends to return the body to health, regardless of the disease state.

culture is ultimately nothing more than the symbols and behavior which define a group of human beings and have evolved through a great number of intergenerational iterations of survival strategies. In any case, our outsider's (emic) point of view cannot override the interviewees' own (etic) unless we have enough quantitative data to contradict them. That is, when people say that their reason for doing something is cultural, it must be respected. This forces us to take a better look at what culture is (Bernard 1995, Weigand pers. comm. 2000).

Paraguayans use medicinal plants for manifold reasons. Among them are to maintain health status and to reduce the workload required to obtain vitamins and minerals by not having to grow vegetables (unconsciously). Perhaps, in light of former and current cross-culturization, they are used mainly as a very powerful mechanism for maintaining cultural identity. The knowledge and use of these plants along with the use of the Guaraní language are the two pillars on which rural Paraguayan cultural identity is supported. Historical reasons for this situation were explained in Chapter 4. Data obtained in researching this thesis support the maintenance of knowledge and use of medicinal plant as a strategy if the term strategy is equivalent to cultural behavior at the two sites. At Eusebio Ayala, 39% mentioned that they use medicinal plants because they are healthy, prevent and cure. At the same site, 48% said they consume these plants because of custom and tradition. At the comparative site, Ñu Pyahú, only 14% said that they consume medicinals because they are healthy, prevent and cure, while 23% of those surveyed responded that custom and tradition were the main reason for their consumption. Interestingly, 54% of Ñu Pyahú respondents said they consume medicinal plants because they taste good.

The term strategy is often associated with conscious intent. Fabrega used the following definition for a drug.

> A drug is a chemical substance that is taken to prevent or cure disease or to otherwise enhance physical or mental welfare. The definition implies a cultural rationale. The purpose for taking substances is crucial to the definition, and this clearly means intentionality and embraces cultural considerations about the procurement, preparation, ingestion, and mode of action of the 'drug.' In addition, since the user wants to enhance his or her welfare, culturally specific ideas about the self, well being, and illness are also implied. These generalizations apply to all societies regardless of what drugs are prevalent and regardless of their conceptions of illness. (1996)

Once again, farming systems research and extension provides a reasonable working answer to the question of what a strategy is. A group of faculty and students at the University of Florida, including Dr. Christy Gladwin, Paul Litow, and Amy Sullivan (Hildebrand, pers. comm., 2000), among others, have defined a livelihood system as the sum of all the strategies or activities used by farmers. As a corollary to this, they have defined any activity within the livelihood system or subset thereof as a strategy. Following this very recent (April 2000) definition, one may conclude that medicinal plant activity is indeed a strategy for rural Paraguayans. This is true before, during, and after the cotton boom of the 1970s and 80s.

Aside from being simply an activity that is a subset of a system, the maintenance of knowledge and use of medicinal plants is an economic strategy if one compares low income farmers at both sites to a sample group of upper-middle class urban Asunción students and professionals. Many of the latter consume medicinal plants. Consumption and especially knowledge are however, neither as widespread nor frequent as the 95% of the respondents to questionnaires in this study, or the 100% of Favitsky's (1997)

interviewees would indicate if they were cross-class national samples. The numbers shown in the table below are closer to reflecting Moreno Azorero's 87% (1986) daily use at the national level or Basualdo's 90% (pers. comm., 1999). The upper-middle class and upper class in Paraguay are small, with estimates ranging from 3 to 5% of the total population. None of the interviewees were in this economic bracket. Therefore, the percentage of higher income city dwellers may have been overlooked. Nevertheless, the present study was conducted to describe one aspect of rural Paraguayan livelihoods at two sites, and there was no intention of undertaking a study at the national level. Quantitative data obtained through surveys show some correlation between medicinal plant consumption and socioeconomic condition (see Table 25 below). The data also indicate that most Paraguayans, even of the wealthier upper classes, consume medicinal plants. What the upper classes do not ordinarily possess is the maintenance of knowledge, use, gathering, and cultivation of medicinal plants. This knowledge in the case of those wealthy individuals who consume medicinal plants on a daily basis is obtained from market stall vendors, domestic employees, office boys and others who have migrated from country to city. Therefore, the socioeconomic reasoning (consumption is at least in part due to poverty) for the knowledge and use of medicinal plants sustained by Basualdo (pers. comm., 1999) is supported by my research.

Table 25. Consumption of Medicinal Plants for Two Different Socioeconomic Groups

Frequency of Use	**Upper/Middle Class Asunción n=30**		**Farmers at Ñu Pyahú, n=22**		**Farmers at E. Ayala, n=23**	
	N°	**%**	**N°**	**%**	**N°**	**%**
Daily	16	53	21	95	23	100
Sometimes	7	23	0	0	0	0
Never	7	23	1	5	0	0

Source: Surveys conducted at two rural sites and in the capital city of Asunción in July-August, 1999.

Distance, Access, and Crop Diversity

The second question posed was: Is greater distance and/or less access to the market place associated with a greater diversity of crops grown, including medicinal plants used in lieu of commercial pharmaceutical products? Many studies from all over the world show a general tendency for farmers closer to the market to grow a small range of cash crops and those further away to grow a wider range of crops, especially subsistence crops. This was true also of the sites researched in Paraguay. At Eusebio Ayala, the site nearer to Asunción, only nine crops were grown. At Ñu Pyahú on the other hand, farmers, who in general fed themselves from the fruits of their own production, grew 17 different crops. However, the effect of market integration can be seen when focusing on just one of the above-mentioned crops, medicinal plants. At Eusebio Ayala interviewees mentioned a total of 86 species. Of these, 37 were cultivated and 49 gathered. At Ñu Pyahú, 250 km from the main market, only 49 species were mentioned altogether of which 28 were cultivated and 21 gathered. The conclusion drawn from these numbers is that the production and gathering of many varieties within one crop is augmented through contact with the market. As women have been taking basketfuls of medicinal plants to the market in Asunción for generations on a daily basis from Eusebio Ayala, they have received inputs from other vendors and requests from clients for different species. These include local species as well as heretofore-unknown foreign ones which small-scale farmers manage to obtain and produce. The market is in this sense both a driver of specialization and a source of information for additional cash crops that leads to a more diverse species composition within one specialty crop.

Table 26. Medicinal Plant Species Grown or Gathered at the Study Sites

Site	Distance in km from Asunción	Average Farm size	Cultivated Species	Gathered Species	Other Crops
E. Ayala	80	< 5 Ha	37	49	8
Ñu Pyahú	250	12 Ha	28	21	17

Source: Surveys conducted at Eusebio Ayala and Ñu Pyahú, July-August, 1999.
See Appendix C for a complete list of species.

Being Better Off

The third question, "Are households better off if they combine market and non-market strategies because they can better maintain food and health security?" is more difficult to answer. Once again, the question involves a term – "better off" – which like the term "strategy" used above has no clear definition and is very subjective in nature. One of the ways of looking at whether households are better off by combining non-market strategies, in this case, the consumption of medicinal plants, is by comparing how much money they spend on healthcare at each site. Farmers at the site nearer Asunción spent a little more than half (Gs. 192,500 vs. Gs. 322,000) the amount compared to those at the more distant site. Those nearer to the market are "better off," in the sense that they need to spend less money at hospitals, health centers, pharmacies, doctors' offices and local healers than those further away do. This may be the result of their exposure to a wider variety of medicinal plants through the market as described above, or other factors that require further research such as education, diet, and influence of distance on healthcare costs. I talked to a woman from near Eusebio Ayala with a three-year-old daughter working as a domestic servant in Asunción. She commented the following to me in August 1999, after seeing how much money was spent on a child's simple cold/flu

by her "patrona" (employer). "If we had to spend that amount of money on medicine each time our child had a cold or the flu, or just catarrh, they would surely die." At any rate, while requiring less money per year to spend on healthcare, these farmers also have more available cash and greater cash flow due to more or less continuous sales in the Asunción market. Although they are more highly integrated into the market economy, only two farmers at Eusebio Ayala grew exclusively cash crops (medicinal plants). All others demonstrated the classical peasant strategy of risk aversion and maintenance of at least minimal food security by growing maize, beans, squash and the ever-present manioc on their farms. If spending less on healthcare is an indicator of being more "well-off," then efforts should be made to initiate programs at the site further from Asunción for improving market integration – without compromising food security – and improving health education.

Tests run on the ELP show that increased expenditures on healthcare in the first and second quarter can affect the outcome of the system to the point of making it infeasible. It is probable that this is known from collective experience and is handled accordingly by consuming medicinal plants to reduce the need for costly medical treatment at both sites. Further inquiry is required to see if those further from modern medical facilities rely more heavily on medicinal plants. The fact that medical treatment is more expensive to them due to higher transportation costs or other reasons than it is to those nearer to healthcare facilities should substantiate higher use, yet consumption approaches 100% at both sites.

Finally, "being better-off" has other connotations besides the strictly material. "Unlike wealth, well-being is open to the entire range of human experience, social,

mental, and spiritual as well as material (Chambers, 1996)." Principal among these is the strong cultural identity associated with the use and knowledge of medicinal plants. Many persons answered the question on why they used these botanicals as simply tradition. Others went so far as to say that it is a fundamental part of being Paraguayan. Reports from Flushing, New York, where there is a flourishing Paraguayan community of some 3,000 members say that medicinal plants (some, not all) are readily available on street corners in the Paraguayan sector of the city (Cardozo, pers. comm., 1999). Buenos Aires as well, which has a Paraguayan population approaching 700,000, has medicinal plant or "yuyo" markets in the Paraguayan neighborhoods. For those Paraguayans in New York, Buenos Aires or anywhere outside their homeland, drinking "mate" (yerba mate) with medicinal plants, and using the Guaraní language provide a feeling of being "better off" in the sense of a cultural identity and sense of belonging to a group. Likewise Paraguayans faced with globalization and cross culturization, especially due to the strong Brazilian presence in the eastern part of the country, may cling to medicinal plants for a feeling of Paraguayanness. This may, in a sense, make them "better off."

Target Group for Medicinal Plant Cultivation Projects

The fourth and final question was ultimately the most important objective of this research. That is: "Can medicinal plants be grown as an alternative cash crop, and by whom?" It addresses both the improvement of small-scale farmer livelihoods and the conservation of medicinal plants at the species level.

There were two main variables considered in determining which households would most likely benefit from the commercial cultivation of medicinal plants. These were household composition and distance from market. Outputs from the linear program

show that farms that will grow medicinal plants to be sold raw and unprocessed should be within a 100-km radius of Asunción and have access to transportation. A daily round trip eight-hour bus ride is the maximum reasonable time that can go into the marketing of these products. As far as household composition is concerned, gender comes into play quite substantially. This is not necessarily due to the fact that women maintain the knowledge of medicinal plants exclusively. In fact, survey results indicate that youngsters learn this knowledge principally from women, but also from men. The gender issue relates directly to the cultural fact that women traditionally gather, grow and especially market, medicinal plants. Male-headed households are likely to adopt the production of medicinal plants if the woman has no small children to care for and therefore have the time available for selling plants at the market. Male-headed households in which the wife has small children are only likely to adopt this technology if adolescent female labor is available. As childcare and medicinal plant sales are fungible labor activities among females of different age groups, this type of family composition provides a feasible result. Mothers can either take care of children or sell medicinal plants. Adolescent females can also sell medicinal plants and/or care for siblings. Female-headed households, the most constrained as far as labor is concerned, can only adopt this technology if there are no small children to care for, or if female adolescents are present so as to be able to share and trade the work of childcare and marketing.

In summary, the recommendation domain for the cultivation of medicinal plants as a cash crop is: households within an eight-hour round trip bus ride to Asunción that have substantial amounts of adult female and/or female adolescent labor available. This refers to the group that is *most likely* to adopt this activity.

As described in Chapter 2, Paraguay is becoming increasingly urbanized. As this trend continues new markets are likely to appear in other cities besides Asunción producing new recommendation domains in the geographical area around them. The household composition requirements would remain unchanged under these circumstances. Since this is a high value specialty crop, biophysical conditions are not generally constraining. Although much research is needed into the ecology and horticultural peculiarities of each species, it can be affirmed in broad terms that a multistrata homegarden environment would provide the best possible conditions with the least input requirements for most tree, vine, and understory species. As these homegardens are by their very nature confined to the areas around the farmhouse, it would be a difficult environment to reproduce on large-scale commercial farms. Species with high light requirements may be grown in open fields as monocrops or intercropped with subsistence row crops. Commercial farmers, however, easily adopt these species.

Recommendations

Six general recommendations emerging from this work are expected to be of use to policy makers designing conservation and development programs related to medicinal plants. Among these are 1) specific households most likely to adopt the cultivation of medicinal plants in Paraguay, 2) the need for further research into agronomic, horticultural, ecological, agroforestry, and other specific studies on individual species production, 3) the need for further research into diet, and the nutraceutical properties of medicinal plants, 4) considerations on how to avoid this potentially lucrative activity from being taken over by corporate interests, and keeping it in the hands of the small-scale producers who need it most, 5) a reminder of the importance of including healthcare

as an important objective of medicinal plant projects and finally, 6) economic justification for why developing country governments should implement medicinal plant healthcare projects.

Saving Financial Resources by Identifying Target Groups

These refer to the households with medium to high female labor availability within a reasonable distance of the target market. These domains were described in greater detail above. It may be useful for development agencies to target these households as those which are most likely to be adopters. Their identification through the ethnographic linear programming process is expected to save effort in the initial phases of planning projects and as an aid in pointing implementers in the right direction.

Need for Production Research

The results and discussion in this thesis are limited to the how and why of medicinal plant use in Paraguay. One of the reasons this was researched was in order to establish the existence of a firm and promising market demand, along with additional benefits from growing medicinal plants. No research was conducted into the specific ecological, agronomic, agroforestry or horticultural practices necessary for the success of production. These aspects of medicinal plants have received little study. Like many spice and essential oil crops, medicinals have very specific requirements ranging from soil and light, to special conditions for seed germination. Clonal reproduction through tissue culture such as that being undertaken at CATIE in Costa Rica (Montiel et al., 1998) while helpful in broad scientific terms, should be carefully regulated as they may tend to become a tool for the removal of production from the hands of small-scale farmers. If this technology must be used because specific plants do not produce viable seeds,

regulatory agencies should take strict measures to insure equitable distribution of reproductive material to all interested parties.

Need for Nutraceutical Research

It was suggested in Chapter 4 that the high rates of medicinal plant use in Paraguay may be related in part to potential mineral and vitamin deficiencies caused by a diet poor in fruits and vegetables. Dietary supplements are being sold in developed countries for boosting immune system function and preventing cancer. The basis for many of these plant-based formulations is anti-oxidants present in certain plants (such as *Dorstenia brasiliensis*) that include vitamins, minerals, flavinoids and other substances.

Comparative studies of human and animal consumption patterns can be useful in establishing the reasons behind medicinal plant consumption. Johns (1990) has conceptualized the role of plants in an organism's adaptational economy as follows "It is difficult to distinguish a pharmacological from a nutritional adaptation in most studies of animal behavior." The term pharmacophagous has been used with respect to insects if they search and use secondary plant substances for uses other than primary metabolism. These same secondary metabolites were developed by plants through evolution for reasons other than their primary metabolism. In groups of chimpanzees, some ill members have been observed to make special use of certain plants during early phases of illness (Hart 1990, Huffman and Seifu 1989, Wrangham and Goodall 1987, Wrangham and Nishida 1983, cited in Fabrega 1996). These observations of close relatives of man who are held to show awareness of self and to possess the rudiments of a theory of mind raise the question of a possible chimpanzee "awareness" of illness, of the environment as a resource for healing, and of a "native pharmacopoeia" (Fabrega, 1996). Many native

folk medical systems use hallucinogenic substances, which allow the healer contact with the otherworldly domain. Eloy Rodriguez and Jan Clymer Cavin (cited in Fabrega, 1996) have suggested that the indole and isoquinoline alkaloids that are found in hallucinogenic plants might have been selected by Amazonian peoples for their antiparasitic properties. This possibility is highly consistent with the formulation of Johns (1990) about the connections between *nutrition*, herbal practices, and the origins of medicine as a cultural institution (emphasis added).

In Africa, food plants dominate lists of medicinal plants. Even today there is no clear distinction in traditional African medicine as to when an herb ceases to be a health food and when it becomes a medicine. In traditional African medicine, many food plants are used for therapeutic purposes, and medicines are not viewed as "necessary poisons (Iwu, 1993)."

Favitsky (1997), González Torres (1985), Burgstaller Chiriani (1987), Johns (1999), and many others have studied nutritional aspects of medicinal plants ranging from their anti-oxidant properties, to improved liver function, to analysis of some species that were high in niacin, riboflavin, magnesium, calcium, and vitamin C. To add to the content of the plant mixtures themselves, consumption behavior patterns which almost always include shared use of a common cup and straw likely have a positive effect in immune system strengthening through the spreading of innocuous doses of germs through saliva (Gaskin, pers. comm., 2000).

Some companies producing yerba mate in Paraguay have – of their own free will – added iodine to the tea. This has begun to prove effective in reducing goiter in certain

areas. This pathway could be very effective and relatively inexpensive for providing other needed oligoelements or vitamins if they should prove necessary.

Finally, a comparative study should be conducted between rural folk who have access to a wide variety of medicinal plants, and dwellers of urban poverty belts who may have a more restricted access to different species of plants. If the latter group shows more common vitamin and mineral deficiencies than the former, more intense studies need to be undertaken to determine the role that daily consumption of medicinal plants play in nutrition. These studies are complex. They need to screen out effects of other factors such as fruit and vegetable consumption and also depressive effects of stress from slum condition living and interference effects from manufactured pharmaceuticals. These studies could prove to be pivotal in a country which to date has suffered little from malnutrition but where it is beginning to appear as workers migrate to cities in search of jobs (Ferreira, pers. comm., 1999).

Keeping Production in the Hands of Small Farmers

Too often, well meaning activities developed originally for resource-limited farmers, appeal to large commercial farmers who then take over the activity. Much scientific research, effort, financial resources, and time are usually invested in these technologies. If the reason for their development was to help small-scale farmers in the first place, then it is reasonable to spend some extra effort in looking into ways for maintaining them in the domain they were intended for. There are several ways to do this. Three will be explained here.

High Labor Inputs

First, detailed study into the amount and type of hand labor that is necessary to produce this crop must be undertaken. Once the cost of labor as a proportion of total production costs has been determined, calculation as to how economic variables, especially minimum wage increases can affect production can be done. The United States Department of Agriculture (USDA) has published several studies on this issue. The studies were undertaken to help determine how immigration policy with regard to migrant farm workers (IRCA) could affect American farmers who grow different crops. It classified crops according to susceptibility to increases or decreases in hand labor cost and availability. Crops were classified according to the share of labor costs in total production cost. These data show that labor's share of production expenses is 44% for horticultural specialty farms, 40% of production costs for fruits and tree nut farms, and almost 37% for vegetable and melon farms. Other field crops, which include cotton and tobacco, have expenditures for labor that represented less than 20% of all production costs. The labor share of production of other farm types, such as cash grains, livestock, and dairy farms were 6, 5 and 10% (Duffield et al., 1989).

This approach can be applied to the production of medicinal plants. This crop most probably would fit under the horticultural specialty crop category with labor making up nearly half of total production costs. This is especially true if production of species that do well only in home garden shade situations is emphasized. In an U.S. Department of Commerce study, it is reported that a high labor factor share indicates a high increase in production costs for a given increase in wages, if the current input mix is maintained. Furthermore, it is assumed that high labor factor shares for individual commodities imply lower than average elasticities of substitution between labor and non-labor inputs and

lower rates of labor saving technological change (U.S.Dept. of Commerce, 1987, cited in Duffield et al., 1989).

Determining the specific needs and describing how these are best met by family labor allows for recommendations that would dissuade large mechanized producers from engaging in this activity. The fact that the chosen medicinal species would be produced in home gardens implies a high rate of family labor inputs. Labor cost share screening indicates that vegetables and melons, fruits and tree nuts and horticulture crops would most likely be affected by higher wages since labor share of total production expenses for these commodities ranges between 36 and 44% (Duffield et al., 1989). Commercial farmers, at least in Paraguay, are accustomed to labor making up only about 10% of total production costs. Their production is highly inelastic to changes in wage or policy or labor availability. They must be informed through extension bulletins and other media that the production of medicinal plant crops is highly susceptible to wage variations and therefore, constitutes a higher risk to them than the low labor input crops they are currently producing. Multi-strata homegardens are not amenable to being managed by large commercial farmers.

It is also reasonable to argue that staying away from high value export crops and producing mainly what the local market can consume is a potential disincentive to commercial farmers. These producers are accustomed to producing commodities with a price based on a Chicago or Liverpool index rather than for local farmers' markets.

Cooperative Effort

Secondly, the need for horizontal rather than vertical integration should be highlighted. In general, policy makers in developing countries seek vertical integration

because this approach, highly favored by the International Monetary Fund and other lending institutions, has shown dramatic improvement in macroeconomic indicators in some countries. A case in point is Chile, where access to market, and specialization in perishables and high-value commodities through individual farmers' and corporate interests, has led to a high share of the U.S. and European import market for these products (Plucknett, 2000). This model however, has led to a reduction in the percentage of rural population (although total numbers may be higher) and increased poverty in peri-urban areas. In summary, while overall export and GNP has increased for Chile, rural workers' well being has not necessarily done so. Horizontal integration – the organization of producers with similar production systems, geographical distribution, goals and aspirations, or some other commonality in cooperatives – produces the opposite effect. In highly structured economies, such as Italy's, where many things, from hay production to shoe and machinery parts manufacture is organized cooperatively, horizontal integration can have an overall positive effect on macroeconomic indicators. This is not always the case in developing country economies. One fact nevertheless must be stressed and brought to the attention of policy makers. Cooperative production, consumption, sales, and credit arrangements very often lead to improved livelihoods for small-scale farmers, keeping a higher percentage of the rural workforce in the countryside and avoiding the overcrowding of urban misery belts incapable of absorbing surplus labor. Examples range from Filipino aquaculture co-ops to small-scale farmer rice production cooperatives in Bangladesh (Plucknett, 2000). One of the areas in which cooperative organization can most help small-scale farmers keep medicinal plant

production in their hands is marketing. The multiplier effect of improved income for small-scale farmers is dramatic.

Marketing

This third and final method discussed here is perhaps the single most important one given today's global economy, marketing. A single small-scale farmer, alone in rural Paraguay cannot be expected to be aware of trends that are in vogue with consumers. Conversely, a group of producers organized in a co-op could, in a relatively short period and without great investment become aware of marketing techniques that not only serve to sell more, but also to make sure that what they sell is a product that only they can produce. Taking advantage of current demand for "organic," "natural," "ethnic," "tropical," "rainforest," green," "sustainably produced," and "pesticide free" products, is most viable in this manner. There is a global, regional, and internal market for these types of products, and it is growing constantly. "Green products" are environmentally safe products that contain no chlorofluorocarbons, are degradable, and /or made of recycled materials. "Deep green" products are those from small suppliers who build their identities around their claimed environmental virtues. "Greened-up" products come from industry giants and are environmentally improved versions of established brands (Bobick, 1997). No matter how hard a commercial farmer tries to market his product as organic or family grown "green products," he cannot outplay a photo of real campesino families producing truly organic crops, broadcast over the Internet. Many of the projects displayed at the Development Marketplace Competition of the World Bank in February 2000, were websites for the marketing of these types of products as well as arts and craft.

Marketing can be done effectively for internal markets and new international markets can better be explored through cooperative effort. Horizontal integration then,

does not exclude vertical integration. Small-scale farmers, banded together can benefit from a greater share of the estimated 15-30,000,000 U$D internal market, and foray into the 5,billion U.S market (Blumenthal, 1999), and ultimately to the estimated U$D17 billion world Market (Akerele, 1991). Opportunities abound, and efforts must be made to include this type of marketing skills and connections in extension programs.

Global Markets

There is a new and growing market for industrialized natural medicines the world over. These markets are both internal and international. The international market demands high standards of purity, and other aspects of quality control. These processes are costly, however and can lead to increased costs for botanical medicines for the general population. Government decisions regarding international trends can affect the environment and the health status of Paraguayans. UNIDO, the United Nations Industrial Development Organization, through its Chemical Industries Branch, Industrial sector and Environment Division, has recognized the growing market for natural products the world over. In their expert opinion, developing countries must overcome the constraints to developing medicinal plant industries. This is necessary in order to confer added value through processing, product improvement, and quality control. De Silva (1997), of UNIDO has cited the lack of knowledge of potential benefits to be gained on the part of local peoples in the developing world by adding value to their medicinal plant resources. Locals in many developing countries generally recognize the value of these plants for primary healthcare needs. In areas of high population density, harvesting of plants from forests and fields has led many species to near extinction. The study of the agronomic properties of these plants could lead to the preservation of biodiversity on a species level,

while at the same time preserving market demand for species, which, unless planted, could disappear from collective use in a very short time.

There are always trade-offs to consider in any situation involving conservation and development. One of these is accessibility by the general population to cheap medicinal plants, versus standardization and industrialization (see above). Implicit or explicit global markets drive the latter process. Markets are explicit when agreed upon through multilateral agreements, and implicit when countries are included in them *de facto*. In Paraguay, a trend has begun very slowly toward some industrialization. This may allow for each customer – according to his/her preferences and possibilities – to decide on which form of a particular plant or mixture he or she will purchase.

The existence of a growing demand for natural body care and nutritional supplements in the developed countries is a window of opportunity that should not be overlooked. With the price of many traditional agricultural products becoming unattractive and greatly fluctuating, any niche available to small-scale farmers, especially the setting up of certified organic grower's cooperatives to cater to the broad overseas market, should be explored for its greatest possible benefit.

Potential Pitfalls of Globalization

Most developing countries are eager to make the most of export potential, as income earned is a major source of foreign exchange. However, the new era of liberalization has provided challenges to many producers, many of whom have had no previous experience of "free market" conditions. Recent trade agreements have also increased the risk that overseas competition may overwhelm domestic production of many products. In addition, producers, smallholder farmers in particular, may at first feel ill-prepared to tackle the task of mastering export procedures and growing a sufficient

quantity of a given minimum quality to be delivered during a very specific period of the year. In practice, only the largest farming companies can undertake the development of new niche markets without specialist advice and assistance. Most producers and processors will succeed only if they form groups or cooperatives and pool their resources in order to exploit modern market demands (FAO, 2000).

The tendency of international markets to enforce standardizing measures and quality controls, however, could have serious implications within national boundaries in a country like Paraguay where medicinal plants are gathered or purchased as raw plant parts at market stalls and street corners at very accessible prices. Globalization could, if viewed in this manner, prove to be as devastating to the widespread use of traditional medicine as loss of habitat. On the other hand, if new markets are found for native Paraguayan species, new laws regulating the extraction of NTFPs and the protection of the habitats where they grow could lead the way in conservation efforts.

The simultaneous existence of two sets of standards, one for export and one for the internal market should be explored. This may prove to be a possible solution for balancing the need to create new employment and export opportunities while maintaining the availability of inexpensive raw medicinal plants for the large sector of the population that require them for personal healthcare (Zhang and Lambert, pers. comm., 2000).

The possibility of growing medicinal plants as cash income activities seems to be feasible for some types of resource-limited farmers. The success or failure of these projects may hinge upon the scale at which they are implemented. If international pharmaceutical conglomerates "devour" this growing market, and take it over from source to final sale (vertical integration), as is their usual practice, the final result may be

a rotund zero. In fact, the unlikely but possible paradox of a Paraguayan "campesino" walking into a pharmacy to buy one of "his own" medicinal plants in capsule or powdered form, with a British, German or American label on it is all too real a possibility.

Healthcare as an Objective

In the past, a high percentage of medicinal plant research and publications focused on the use of medicinal plant knowledge and its need by local people as a means to promote conservation projects and secondarily as a bank for obtaining "miracle drugs" to cure cancer or AIDS. Although the link between medicinal plants and conservation is extremely important it cannot supersede the need for medicinal plants for affordable healthcare. The World Bank and the Global Forum for Health Research share a central concern for improving the health of the world's poor. At present, of the US$ 60 billion spent worldwide annually on health research by both the public and private sector, only about 10 % is devoted to 90% of the world's health problems. The economic and social cost to society as a whole of such misallocation of resources is enormous, both directly and indirectly. The direct costs are particularly high for the poorer population, given the vicious circle between poverty and poor health (Currat and Lovelace, 2000). The World Health Organization has begun to address this so-called 10/90 divide by setting up the Traditional Medicine Program in four West African countries. The schematic action plan to produce benefits in this area includes three overlapping objectives, which are the validation of phytomedicines, securing medicinal plant resources, and affordable healthcare for all (Lambert and Zhang, pers.comm., 2000). The Pan American Health

Organization (PAHO) has recently initiated a program in the same area (Land, pers. comm., 2000).

The production of needed medicinal plants by certain small farmers in rural Paraguay fits well into this scheme. They will be securing medicinal plant resources through *ex-situ* cultivation. Paraguay is perhaps one of the countries in which a medicinal plant program could achieve great success. Data presented in this thesis are expected to lend support for the initiation of such a project in Paraguay.

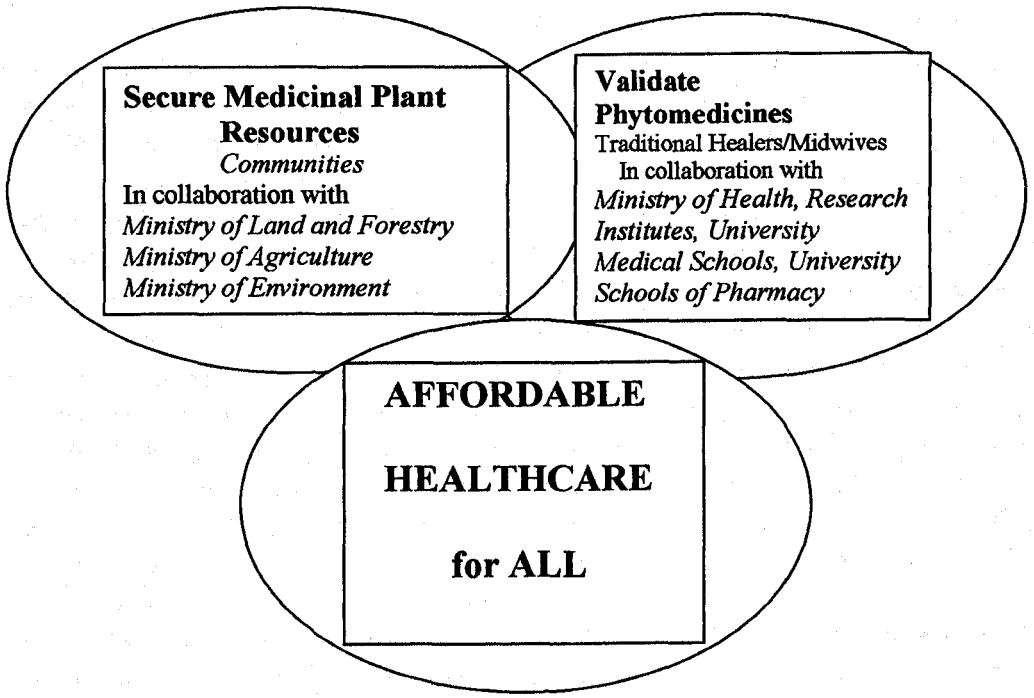


Figure 3. Actions Produce Benefits

Source: World Bank – Rural Development (AFTR2), World Health Organization – Traditional Medicine Program, Natural Resources Institute U.K. Pilot Countries: Ghana, Nigeria, Benin, Cameroon.

Economic Justification for Medicinal Plant Projects

Government policy makers find it difficult to justify investments in medicinal plant healthcare projects. A useful tool for their economic justification of these types of programs is the knowledge of the production function of healthcare and the marginal product of healthcare. In Figure 4 below health status is shown as an increasing function of healthcare. Health status depends on a population's biological endowment, environment, and lifestyle Thus HC = f(Healthcare, Life Style, Environment, Human Biology). Improvements in any of these three latter factors will shift the curve upward.

In practice, the number of healthy days experienced by the population per capita or the reciprocal of the reverse indicator such as mortality rates or disability days may be used to indicate health status. In reality, healthcare consists of many healthcare inputs. Conceptually, the healthcare measure, HC, may be thought of as an aggregate of all types of healthcare based on dollar value. The use of medicinal plants in homeopathic doses on a daily basis or as a dietary supplement by the general population could shift the curve upward.

More important, from a policy maker standpoint, is the concept of the marginal product of healthcare (see graph B in Figure 4 below). This refers to the increment to health caused by one extra unit of healthcare, holding all other inputs constant (Folland et al., 1993). Government expenditure allocation is often based on marginal rather than direct costs. It would be very difficult to reassign amounts that are already in place, such as doctors and nurses' salaries, maintenance of health posts, procurement of basic medical supplies, etc. This is due to institutional inertia or momentum (Hildebrand, 1999) and the fact that the current healthcare status of the population be what it may,

cannot be exposed to the risk of eliminating any inputs which could jeopardize it. On the other hand, reasonable amounts of money could be shifted from ordinary expenditures in a year to a medicinal plant program that would have a broader impact on general health in a place like Paraguay.

For example, let us say that there are 300,000 US$ from the marginal or extra healthcare budget of a given year that were earmarked for the purchase of one magnetic resonance machine or the construction of six hospital rooms with equipment. These investments could help a good number of people in a period of three years. Assuming full-bed occupancy and 50% use of the magnetic resonance machine, nearly 10,000 persons would benefit in a period of three years. If, on the other hand, this same amount of money were invested in a well-designed medicinal plant for healthcare program, the potential number of beneficiaries in the same time period would be between ten and one hundred times that of the previous example. In developing countries with strained budgets and limited resources, it makes not only economic sense, but also common sense to implement this type of project.

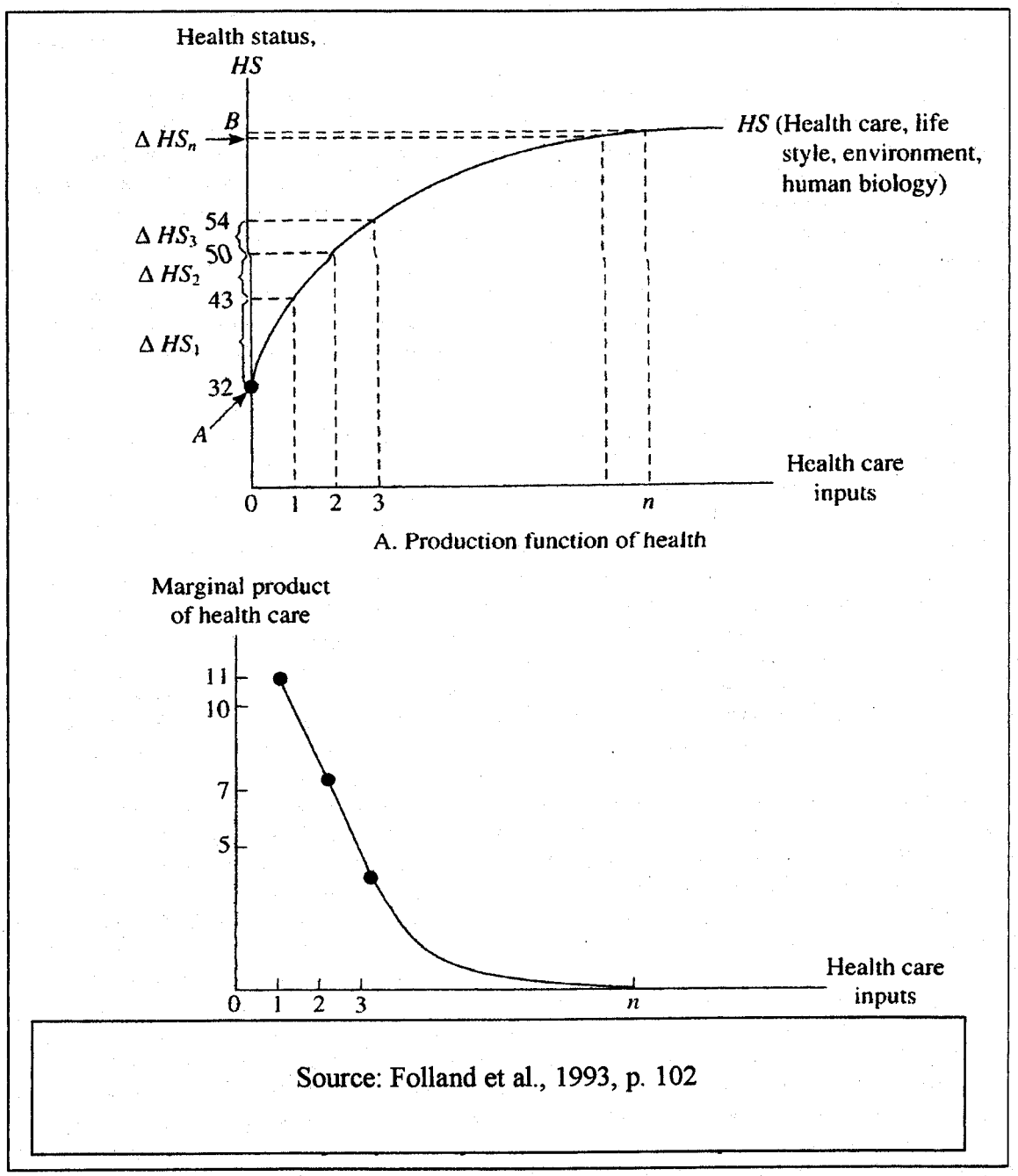


Figure 4. The Production Function and Marginal Product of Healthcare

APPENDIX A
SURVEY RESULTS

Question 1. What do you think of the quality of your water?

Quality	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Good	9	39	13	59
Very good	3	13	6	27
Excellent	1	4	0	0
Did not answer	10	44	3	14

Question 2. How would you typify the quality of your soil?

Quality	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Very Good	0	0	3	14
Good	16	70	15	68
Medium	5	22	4	18
Bad	1	4	0	0
Did not answer	1	4	0	0

Question 3. Has there been a change in your soil quality?

Change	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Improved	5	22	2	9
Does not know	3	13	0	0
There has been no change	10	44	18	81
Is worse	4	17	1	5
Did not answer	1	4	1	5

Question 4. Has there been any change in the frequency of rains?

Change	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Yes	13	57	3	14
No	6	26	2	9
Did not answer	1	4	0	0
Yes it has increased	2	9	2	9
Yes, it has decreased	1	4	15	68

Question 5. In the forest around here, are there many animals and birds?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Did not answer	2	9	0	0
No	7	30	0	0
There is no more forest	3	13	0	0
There are less than before	1	4	18	82
There are birds , not animals	1	4	0	0
There are still many	6	26	4	18
There has been no change	3	13	0	0

Question 6. Do you know anyone who has been intoxicated by pesticides in your area?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
No	6	26	16	73
Yes	16	70	6	27
Did not answer	1	4	0	0

Question 7. Have you ever heard of a National Park or Sanctuary in your Department?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Yes	8	35	3	14
No	14	61	19	86
Did not answer	1	4	0	0

Question 8. Do you think that it is important to create new parks or protected areas?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Yes	18	78	21	95
No	4	17	1	5
Did not answer	1	4	0	0

Question 9. Do you know people who still fish and hunt a lot in this area?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
No	13	57	4	18
Yes	7	30	17	77
Did not answer	3	13	1	5

Question 10. Why do you use medicinal plants?

Reason	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
They are healthy, prevent and cure	9	39	3	14
Custom and tradition	11	48	5	23
They taste good	1	4	12	54
To save money	1	4	2	9
They are accessible	1	4	0	0

Question 11. How do you consume these medicinals?

Reason	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
In mate and tereré	22	96	19	86
In mate, tereré and tea	1	4	3	14

Question 12. Do you also use medicine purchased at pharmacies?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Yes	6	26	19	86
Sometimes	7	30	0	0
No	1	4	3	14
Medicinal plants first, then purchased medicine.	9	39	0	0

Question 13. When was the last time you bought something at the drugstore?

When	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Two months ago	2	9	3	14
I don't remember	6	26	6	27
Sometimes	1	4	0	0
Within the past month	5	22	6	27
Did not answer	2	9	0	0
I don't buy them any more	2	9	0	0
Last week	3	12	4	18
Six months ago	2	9	3	14

Question 14. What did you purchase?

Type of Medicine	Eusebio Ayala	Ñu Pyahú
Anti-inflammatories	1	0
Flu pills or syrups	2	0
Pain killers	4	7
Cough medicine	4	2
For stomach or intestinal ailments	1	0
Sedative	0	1
For anemia	1	6
Antibiotics	0	3
Does not remember	0	5

Question 15. Do you use medicinal plants and pharmaceuticals together?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Yes	17	74	20	91
Yes, when it is grave	4	17	0	0
No	1	4	2	9
Did not answer	1	4	0	0

Question 16. Which do you prefer?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Medicinal plants	16	70	16	73
Med. Plants + pharmaceuticals	7	30	4	18
Purchased pharmaceuticals	0	0	2	9

Question 17. Who did you learn to use the different mixtures from?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Father, mother and grandparents	3	13	1	5
Tradition	13	57	2	9
From other medicinal plant vendors	1	4	0	0
Did not answer	1	4	2	9
Mother	1	4	13	59
Father	1	4	2	9
Grandmother	1	4	1	5
Father and mother	1	4	0	0
Mother, relatives, and old folks	1	4	0	0
Friends	0	0	1	5

Question 18. How do you feel in general about your health?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Good	21	91	14	64
Very good	1	4	0	0
So so	1	4	7	32
Poor	0	0	1	5

Question 19. What sickness or illnesses has your family suffered during the past twelve months? Number of persons who mentioned each illness.

Illness	Eusebio Ayala	Ñu Pyahú
Coughing	14	3
Flu	15	6
Colds	2	0
Almost nothing	2	0
Intestinal parasites	7	1
Stomach problems	2	2
Diarrhea	3	2
Vomiting	1	0
High blood pressure	4	6
Constipation	1	0
Fever	1	0
Rheumatism	1	1
Accidents at work	1	0
Low blood pressure	0	2
None	0	4

Question 20. What did you use to treat each of these illnesses?

Remedy	Eusebio Ayala		Ñu Pyahú	
Only medicinal plants	Cough and cold	7	Cough and cold	20
	Stomach problems	2	Stomach problems	18
	Diarrhea	3	Diarrhea	17
	Parasites	5	Parasites	7
	Flu	7	Flu	18
	High blood pres.	1	High blood pressure	8
	Constipation	1	Low blood pressure	1
	Other	5	Aches and pains	16
Purchased medicines	Flu	1	Flu	3
	High blood pressure	1	High blood pressure	2
			Parasites	2
			Diarrhea	2
Combination of med. Pl. and purchased medicine	Cough	6	Flu	2
	Flu	7	Parasites	2
	Parasites	3	High blood pressure	2
			Diarrhea	2

Numbers indicate total answers in surveys.

Question 21. Which are the medicines you purchase most at the pharmacy? (Persons who mentioned each type of medicine).

Medicine	Eusebio Ayala	Ñu Pyahú
Cough Syrup	7	4
Flu pills	9	2
Antibiotics	2	11
Analgesics (pain killers)	17	9
Allergy pills	1	0
Vitamin C	1	0
Sedative	1	0
First aid	1	0
Antihelminthic	0	1

Question 22. How and where are medicinal plants grown on your farm?

Answer	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
In pots for use and sale	5	22	1	5
In the vegetable garden	5	22	10	45
Did not answer	1	4	1	5
In the home garden	10	43	5	23
In the crop field	2	9	5	23

Question 23. How long does it take you to gather medicinal plants?

Time per day	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Around 15 minutes	17	74	13	59
30 minutes	1	4	6	27
Does not gather	4	17	0	0
Did not answer	1	4	3	14

Question 24. Are there some medicinal plants that are harder to get or can no longer be found?

Plant	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Yes	15	65	7	32
No	8	35	12	55
Did not answer	0	0	3	13

Question 25. How long did you work in your medicinal plant garden last week?

Time per day	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
Did not work	10	43	1	4
One to two hours	5	22	9	41
Very little	2	9	3	14
24 hours	2	9	3	14
Did not answer	4	17	6	27

Question 26. Do your children help you with this work? If so, how long did they work last week?

Time per week	Eusebio Ayala		Ñu Pyahú	
	No.	%	No.	%
No	11	48	0	0
Yes, seven hours	6	26	3	14
Yes, six to 24 hours	6	26	13	59
Did not answer	0	0	6	27

Question 27 A- Did somebody help you plow your land?

The sons	(8)
No	(16)
Yes	(2)
Hired labor	(4)
The daughter	(1)
Did not answer	(2)

Question 27 B- How many days did it take?

The average answer was six.

Question 28. How many plots of land do you have?

One (31)
Two (8)
Four (2)
Works on father's land (4)

Question 29. What size are they?

½ Ha (3)
¼ Ha. (4)
4 Ha.(2)
8 Ha. (2)
10 Ha.(18)
12 Ha. (2)
15 Ha.(12)
17 Ha.(2)

Average farm size was 13.23 ha at Ñu Pyahú and 4.94 ha at La Cordillera, although many farmers at this latter site possess less than one ha. The average between both sites was 9.09 ha. However, four farmers as can be seen above had no land at all, and worked on their father's land.

Question 30. Do you have legal titles to this land?

No	(8)
Going through the process	(10)
Yes	(27)

30 A- In whose name?

The husband	(28)
Husband and wife	(2)
Going through the process	(12)
The father's	(2)
The wife	(1)

Question 31. What types of land and land use make up your farm?

Use	ha.
Field with little or no slope	3 ½
Hillside field	1.2
Pasture	0.6
Fallow	3.8
Marshy land	1.9
Forest	3.1
Fruit trees	0.6
Other	0.6

These numbers are averages for both sites. The Eusebio Ayala numbers are skewed upwards by the relatively large landholdings at Ñu Pyahú. It must be recalled that many farmers at Eusebio Ayala had less than one ha of land.

Cash Needs

Question 32. How many people make up your family?

The average was six ranging from two to eleven.

Question 33. Are there other persons who eat or live with you?

All interviewees answered no except for two, who said that grandchildren ate with them.

Question 34. How much money do you need this year for the following activities?

The following are averages from 43 interviews.

Activity	Guaraníes
To begin agricultural activities	420,000
For pesticides and seed	140,000
For hired help in the field	200,000
To hire help for the harvest	150,000
To go to the market and sell products	340,000
To buy school uniforms and supplies	85,000
To pay for medical appointments	
Or treatment at:	
The local pharmacy	80,000
The Health Center	52,000
Private medical office	32,000
At the hospital	45,000
With a traditional healer	28,000
For Christmas and New Years	100,000
For Easter week	120,000
For birthdays and other celebrations	77,000

Question 35. Did you receive any money remitted from Asunción or elsewhere this year?

Thirty one answered no and eight said yes.

Question 36. Did you earn money working off the farm this year?

Thirty four said yes and nine said no.

Question 37. Who decides the purchasse of new clothes?
This question was asked to see how money is handle in the household.

Twelve people answered that the father decides; six that the mother decides; fourteen said that both decide; and eighteen said that "necessity" decided. Three did not understand the question.

Question 38. Who takes the products to market for sale?

Twenty eight interviewees answered the father; ten said it was the mother; and three answered that both shared this responsibility, while two said they sold all products at the farm gate.

Question 39. How much did you spent last month on groceries?

The average expenditure was Gs. 240,000.

Product	Gs.
Cooking oil	32,000
Meat	90,000
Flour	12,000
Yerba mate	14,000
Sugar	12,000
Tomato paste	10,500
Beverages	31,000
Soap	9,000
Kerosene	2,500
Rice	13,000
Pasta	14,000
Total:	240,000 per month

Question 40. Please detail how much of the following you ate last month.

Article	Amount
Rice	6 kg
Pasta	6 kg
Cooking oil	9 lt
Meat	15 kg
Flour	6 kg
Yerba mate	8 kg
Manioc	145 kg
Maize	14 kg
Cowpeas	7 kg
Peanuts	4 kg
Squash	3 kg
Fruits	15 dozen citrus and 15 dozen bananas
Sugar	7 kg
Tomato paste	13 units
Cigarettes	15 packs
Beverages	5 lt soft drinks
Coconut	4 kg
Milk	120 lt (in season)
Cheese	5 kg
Chickens	5
Eggs	20 dozen
Soy milk	90 lt (when cow milk is unavailable)
Soy coffee	5 kg

Question 41. Of these, which do you produce in your fields?

Manioc	(26)
Cowpeas	(22)
Meat	(4)
Fruit	(10)
Squash	(6)
Maize (chipá)	(24)
Maiz (tupí pytá)	(24)
Vegetables	(6)
Peanuts	(4)
Soybeans	(2)
Everything, except rice, pasta, meat, oil and yerba mate	(2)
Watermelons and melons	(2)
Peas	(2)
Eggs	(38)
Did not answered	(4)

Question 42. What did you eat yesterday? Does this vary during the year?

Tortillas de mandioca	(Manioc dumplings)	(10)
Locro	(Hominy soup)	(8)
Arroz Quesú	(Rice with cheese)	(4)
Cocido	(yerba mate coffee)	(14)
Guisado mandió	(Manioc stew)	(4)
Gallina	(Chicken soup)	(2)
Pato	(Duck stew)	(2)
Chancho	(Pork)	(4)
Sopa paraguay	(Cornbread)	(2)
Mandioca	(boiled manioc on the side)	(34)
Guiso de fideo con carne	(Noodle and meat stew)	(12)
Guiso de Arroz con carne	(Rice and meat stew)	(6)
Kumandá fideo	(Beans with pasta)	(2)
Tortilla de harina y arroz	(Flour and rice dumplings)	(12)
Café	(Coffee)	(2)

Question 43. What products do you exchange or barter with your neighbors?

Manioc	(24)
Cowpeas	(16)
Maize	(8)
Meat	(4)
Cooking oil	(2)
Squash	(2)
Milk	(2)
Does not barter	(7)
Did not answered	(4)

Question 44. Did you purchase powdered milk or any other special baby food or infant items?

Yes	(14)
No	(28)
Sometimes	(2)
Did not answered	(1)

Question 45. Who prepared the meals yesterday?

The mother	(34)
Mother and daughters	(8)
The daughter	(1)

Question 46. How much time did it take you to cook?

One hour	(12)
One to two hours	(18)
Two hours	(7)
Three hours	(4)
Four hours	(2)

This question was asked in order to determine time left over for other activities

Question 47. What other activities were you doing while preparing the meals?

Cleaning	(41)
Cleaning, feeding animals and washing clothes	(2)
Housework and caring for children	(2)

APPENDIX B

LIST OF MEDICINAL PLANTS

Table 57. Common and scientific names of medicinal plats consumed by small farmers at Aguaity, Eusebio Ayala and Ñu Pyahú, Caazapá.

Common Name	Scientific Name	Family	Plant Part Used
Perdurilla	Gomphrena decumbens	Amaranthaceae	WP(whole plant)
Mbocaya í	Acrocomia totai	Araceae	R (roots)
Ysypó Milhombre	Aristolochia triangularis	Aristolochiaceae	V (vine)
Agrial	Begonia semperflorens	Begoniaceae	L (leaves)
Borraja	Borago officinalis	Boraginaceae	S (seeds)
Caraguata í	Aechmea polystachya	Bromeliaceae	L
Mamone macho poty	Carica papaya	Caricaceae	F (flower)
Cangorosa	Maytenus aquifolium Maytenus ilicifolia	Celastraceae	RB (root bark)
Kaa ré	Chenopodium ambrosioides var. Anthelminticum	Chenopodiaceae	L,F
Capi í Catí	Killyngia odorata	Cyperaceae	Rh (rhizome)
Santa Lucía	Commelina nudiflora	Commelinaceae	WP
Ajenjo	Artemisia absinthium	Compositae	L
Doctorcito	Eupatorium inulaefolium	Compositae	R
Chicoria	Cichorium intybus	Compositae	L
Manzanilla	Anthemis nobilis Matricaria chamomilla	Compositae	F
Raído Sombrero	Taraxacum officinale	Compositae	L
Tapecué	Acanthospermum xanthioides	Compositae	R
Vira vira guasú	Gnaphallium purpureum	Compositae	L
Yaguareté kaá	Baccharis gentilloides var. trimera Baccharis articulata	Compositae	L
Yateí ka á	Achirocline alata	Compositae	F
Yaguarundí	Piper fulvescens	Compositae	L
Ka á he é	Stevia rebaudiana	Compositae	L
Yerba de lucero	Pluchea suaveolens	Compositae	L
Batatilla	Ipomeia nitida Pfaffia sp.	Convolvulaceae	T (tubers)
Mbaracayá Nambí	Dichondra repens	Convolvulaceae	L
Andaí	Cucurbita moschata	Cucurbitaceae	EF (exudate of fruit)
Cola de Caballo	Equisetum giganteum Equisetum sp.	Equisetaceae	L

	Equisetum sp.		
Pará para í	Phylantus niruri Phylantus lathyroides	Euphorbiaceae	WP
Burrito	Wandita calysine	Geraniaceae	L,TB(tender branches)
Cedrón capi í	Cymbopogon citratus	Gramineae	L
Tacuara saijú	Guadua sp.	Gramineae	R
Alucema	Lavandula officinalis	Labiatae	L
Menta-í	Mentha x piperita	Labiatae	L
Romero	Rosmarinus officinalis	Labiatae	L
Salvia	Salvia officinalis	Labiatae	L
Yerba buena	Mentha rotundifolia	Labiatae	L
Aguacate rogue	Persea americana	Lauraceae	L
Laurel	Nectandra lanceolata	Lauraceae	L,B
Taperyvá hu	Cassia occidentalis	Leguminosae	WP
Alfalfa	Medicago sativa	Leguminosae	L,TB
Tahá tahá	Desmodium sp.	Leguminosae	WP
Ingá	Inga uruguensis	Leguminosae	L,F
Aloe	Aloe vera Aloe arborescens Aloe saponaria	Liliaceae	EL (exudate of leaves)
Zarzaparrilla o Juapeká	Smilax campestris Smilax officinalis Herrería montevideana	Liliaceae	T
Siete sangrías	Cuphea mesostemon Cuphea racemosa	Lythraceae	WP
Malva blanca	Malva rotundifolia Malva silvestris	Malvaceae	L
Boldo	Peumus boldus	Monimiaceae	L
Ambay Saiyú	Cecropia pachystachya Cecropia peltata	Moraceae	L
Mora rogué	Morus nigra Chlorophora tinctorea	Moraceae	L
Taropé	Dorstenia brasiliensis	Moraceae	R
Eucalipto	Eucaliptus globulus	Myrtaceae	L
Eucalipto mentolado	Eucaliptus cinerea	Myrtaceae	L
Ñanga piry	Eugenia uniflora	Myrtaceae	L, TB
Ka arú rupé	Boerhaavia hirsuta	Nygtaginaceae	WP
Yatebu ka á	Peperonia cyclophylla	Piperaceae	L,V
Llantén Kokué	Plantago tomentosa	Plantaginaceae	WP
Culantrillo	Adiantum cuneatum	Polypodiaceae	L
Kalawala	Polypodium phyllitidis	Polypodiaceae	L
Aguapé puru á	Eichornia crassipes	Pontederiaceae	L
Doradilla	Cymnopteris ruffa	Pteridaceae	L

Rosa mosqueta	Rosa moschata	Rosaceae	F
Ñandypa	Genipa americana	Rubiaceae	L
Limón común	Citrus limonum	Rutaceae	L,F
Naranja jhai	Citrus aurantium var. amara	Rutaceae	L,F
Ruda	Ruta graveolens	Rutaceae	L,TS
Kokú	Allophylus edulis	Sapindaceae	L, TS
Yuruvéva	Solanum paniculatum	Solanaceae	L
Typychá kuratú	Scoparia dulcis	Scrophulariaceae	L,TS,F
Tilo	Tilia sp.	Tiliaceae	L
Eneldo	Anethum graveolens	Umbelliferae	L
Hinojo	Foeniculum vulgare	Umbelliferae	L
Caraguata ru a	Eryngium floribundum	Umbelliferae	L
Ka á piky	Parietaria debilis	Urticaceae	L
Pyno í	Urtica urens	Urticaceae	L
Cedrón Paraguay	Lippia citriodora= Aloysia triphylla	Verbenaceae	L,TS
Poleo de Castilla	Lippia ligustrina var. paraguayensis	Verbenaceae	L,TS
Poleo í	Lippia polegium	Verbenaceae	L,TS
Verbena í	Verbena intermedia	Verbenaceae	L,TS

L=leaves, WP = whole plant, TS = tender stems, F = flowers, RB = root bark, V = vine, E = exudates, R = root

Classification according to comparison of common names with collection at the department of Botany. Faculty of Chemistry, Universidad Nacional de Asunción, San Lorenzo, Paraguay. No vouchers collected as deemed unnecessary due to common nature of plants cited. Leguminosae is used for all plants previously classifies as such.

Source: Surveys conducted at Eusebio Ayala and Ñu Pyahú, July-August, 1999.

APPENDIX C

FARMING SYSTEMS DATA

Linear Programming Data Obtained through Interviews

Table 1. Cowpea

Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Plowing	7				
Sowing	5	1	1		
Weeding	9	2	3	2	
Spraying	3				
Harvest	12	7	10	10	2
Hauling	1	1	2		
Shucking	2	2	2	2	3

Table 2. Manioc

Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Plowing	8			2	
Sowing	5				
Weeding	12		3	3	3
Harvest		2	10	10	2
Hauling		6	2	4	1

Table 3. Squash, Watermelon, Melon

Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Plowing	5				
Sowing	2				
Weeding	8				
Spraying	12				
Harvest	2		3	5	
Hauling	2				

Did not answer or do not plant (10)

Table 4. Cotton

Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Plowing	12				
Sowing	1				
Weeding	18		4	4	
Spraying	12				
Harvest	11	3	4	3	14
Hauling	2				
Storage				2	

Table 5. Peanut

Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Plowing	3				
Sowing	4				
Weeding	12				
Harvest	8				
Hauling	2				
Storage	0,5				
Selling	0,5				

Table 6. Medicinal Plants

Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Plowing	1				
Sowing	1	2			
Weeding	2	2.5	1		
Harvest		16	1		

Did not plant (12)

Table 6A -Do you have perennial crops?

Yes	24
No	10

Table 6B -Perennial Crops

Crop	Activity	Man days	Woman days	Male teen days	Female teen days	Child days
Elephant Grass	Planting, Cutting	14				
Citrus	Weeding Planting	2	3	3		
Mango	Weeding and pruning	8				
Coconut	Gathering		3	2	3	4
Sugar Cane	Planting, Cutting Weeding	5	3	12		

Table 6C -Years after planting until first harvest of fruit, leaves or other

Crops	Years
Citrus	3
Mango	3
Yerba Mate	4

Table 7. Domestic animals

Animal	Amount spent on feed or Medicine in Gs.(per year)	Purchase or Sales price	No. consumed this year at home	Mortality
Horse	20,000	350,000		
Milking Cow	60,000	310,000	1	
Steer	20,000	320,000		
Hens	16,000	5000	20	Sudden death due to pest
Pigs	10,000	30,000	5	
Oxen	3,000	1,000,000		
Duck	1,000	2,500		

Farming Systems Information from Secondary Sources

Table 8. Whole Sale Prices for Basic Farm Products at Market

Product	Price (Gs.)	Unit
Oranges	4,000	Bag x 100 Units
Tangerines	9,000	Bag x 100 Units
Hybrid mango	6,000	kg
Yerba mate leaves	450	kg
Coconut	15,000	Crate x 20 kg
Maize	120	kg
Cowpea	170	kg
Peanut	230	kg
Squash	70	kg
Honey	13,000	lt
Banana	8,500	Crate x 25 kg
Medicinal plants	40,000	Bag

Table 9. Daily Wages for Hired Labor

San Pedro	4,000 Gs/day – without lunch
Central	17,000 Gs/day – without lunch
Canindeyú	12,000 Gs/day – without lunch
Chaco	10,000 Gs/day – lunch included

Table 10. Miscelaneous Prices

Price of a pair of oxen	2,300,000
Price of a disc harrow	1,800,000

Source: Monthly report of the Office of Commerce of the Ministry of Agriculture and Livestock (August 1999).

Table 11. Average Monthly Consumption (1990-1991)

Reference: Typical Family made up of father, mother, and three children.

Manioc	18.625 kg
Maize	20.45 kg
Peanut	6.420 kg
Squash	0.837 kg
Meat	14.16 kg
Milk	48 lt
Yerba mate	20 kg
Sugar	7 kg
Oil	18 lt

Source: Report from the Department of Economic Studies of the Central Bank of Paraguay.

Table 12. Workdays Required per Crop per ha

Crop	Plowing	Hoeing	Harvest	Storage	Hauling
Maize	3 M	6 M 3 W	12 M 4 W 2 Ch	8 Ch	0.2 M
Peanut	3 M	2 M 2 Ch	16 M 6 W 6 Ch	5 Ch	0.2 M
Manioc	3 M	2 M 4 Ch	20 M 10 W	5 Ch	4 M
Bean/ Cowpea	3 M	3 M 4 Ch	12 M 10 Ch	8 M 10 Ch	0.3 M 0.5 Ch
Squash	3 M	3 M	10 M	10 Ch	4 M

Source: Ministry of Agriculture and Livestock, Paraguay, August 1999.
Workday Equivalents:
M = 1.0 (Adult male); W = 0.75 M (Adult female); Ch = 0.5 M (Child).

Table 13. Average Yield

Crop	Solecrop (kg/ha)	Intercrop (kg/ha)
Maize	4,000	2,000 w/bean and peanut
Peanut	1,000	500 w/manioc
Manioc	20,000	10,000 w/ bean or peanut
Squash	10,000	5,000 w/maize
Oranges	450 bags. 20 kg/bag	N/A
Tangerines	500 bags 20 kg /bag	N/A
Mango	600 bags 20 kg/bag	N/A

Source: Ministry of Agriculture and Livestock, Paraguay, August 1999.

Table 14. Pesticides for Common Crops

A. Maize

Herbicides	Dose	Price	Use
Atrazine 50%	3 lt/ha	5 U$/lt	Early pre-emergent
Atrazine + Zimazine	4-6 lt/ha	4 U$/kg	Early pre and early post/mergent

Insecticides		
Chlorphiriphos	600/900c.c/ha	12.5 U$/lt
Cipermetrine 25%	40/60 c.c./ha	14.0 U$/lt

B. Peanut/Bean/Cowpea

Herbicides			
Trifuraline	4 lt/ha	16.0 U$/lt	Pre-emergent
Imazetaphir 10%	0.5 lt/ha	39.0 U$/lt	Pre-emergent
Sethoxidim 18%	1.5 lt/ha	20 U$/lt	Pre-emergent

Insecticides: idem maize

C- Manioc

Herbicides	Dose	Price	Use
Metribuzin	1 lt/ha	US$ 18/lt	Pre-emergent

Insecticide	Dose	Price	Use
Carbaryl	3 lt/ha	US$ 12/lt	N/A

D- Squash

Fungicide			
Captam	200 cc/ha	US$ 13/lt	

Insecticides: idem maize

Source: Private Agricultural Consultants in Paraguay, August 1999

APPENDIX D

BASELINE ETHNOGRAPHIC LINEAR PROGRAM

		Peanut melons squash coconuts	Maize	Manioc	Cotton	Cowpea	Citrus and/or Mangos	Medicinal plants	Sell Medicinal plants 1st Q	Sell Medicinal plants 2nd Quar
Variables>>		0.06	1.734694	0.311111	1.7E-16	0.103098	0	0.006935	0	0
[redacted]	ha	1	1	1	1	1	1	1		
MLabor 1st quar	days	4	3	3	9					
MLabor 2nd quar	days	6	5	8	14	12	4			
Mlabor 3rd quar	days	4	6	6	12	3				
MLabor 4th quar	days	2	5	6	10	6	4			
FLabor 1st quar	days				8			10	0.3	
FLabor 2nd quar	days	6	3	3	14	4	4	10		0.3
FLabor 3rd quar	days		1	3	8	5		10		
FLabor 4th quar	days	2	2	3	6	6	4	10		
[redacted]	days	0					0			
MTeenLabor1stQ	days			2	2			6		
MTeenLabor2ndQ	days	2	2		4	4	4	8		
MTeenLabor3rdQ	days	2	2	2	4			2		
MTeenLabor4thQ	days	2		2	2	2	3	8		
FTeenLabor1stQ	days			1	2			6	0.3	
FTeenLabor2ndQ	days	2	2	3	4	4	3	6		0.3
FTeenLabor3rdQ	days	2	2	1	4			6		
FTeenLabor4thQ	days	2		1	2	2	3	6		
KidsLabor 1stQ	days				2			6	0.3	
Kids Labor 2ns Q	days	1	1	1	2	2	4	6		0.3
Kids Labor 3rd Q	days	1		1	4			6		
Kids Labor 4th Q	days	1		1	2		4	6		
Maize Consump	kg									
Maize acctg	Gs.		-980							
Cassava connsm	kg									
Cassava acctg	Gs.			-4500						
Fruit Consump.	frutas									
Fruit Acctg.	Gs.						-70			
Peanut Consum	kg									
Peanut Account	Gs.	-1000								
Squash consum	kg									
Squash Acctoun	Gs.	-5000								
Cowpea consum	Kg									
Cowpea acctg.	Gs.					-1000				
Cotton acctg.	Gs.				-800					
coconut acctg	crates	-20								
coconut consum	Kg									
MedPlanconsum	bolsas									
Medplantsacctg	Gs.							-1400	1	1
Beg Cash 1st Q	Gs.							100000	-75000	
Beg Cash 2ndQ	Gs.									-75000
Beg Cash 3rd Q	Gs.	60000	60000	40000	300000	60000				
Beg Cash 4thQ	Gs.						120000			
totCashEndYea										

Sell Medicinal plants 3rd Quar	Sell Medicinal plants 4th Quar	Sell Squash	Sell Peanuts	sell coconuts	Sell Manioc	Sell Fruit	Sell Cowpea	Sell Cotton	Sell Maize	Sell off-farm labor 1st Q
0	9.70833	0	0	41.29772	0	0	0	0	0	19.33617
		0	0	1	0.01	2	0.1		0.01	1
		0.1	0.1	1	0.01		0.1		0.01	
		0.1	0.1	0	0		0.1		0.01	
		0					0.1			
0.3						4				
	0.3					4				
										1
0.3										
	0.3									
						4				
0.3						4				
	0.3									
									1	
					1					
						1				
			1							
		1								
							1			
								1		
				1						
1	1									
						-15000				-25000
		-10					-1300	-700		
-75000			-350						-200	
	-75000			-3000	-100					

Sell off-farm labor 2nd Q	Sell off-farm labor 3rd Q	Sell off-farm labor 4th Q	maize transfer	cassava transfr	Cowpea transfer	Coconut Transfer	Fruit Transfer	Med plai Transfer	Squash Transfer	Peanut Transfer
15.9427	15.7745:	0	170C	140C	60	0	0	3	12	60
1										
	1									
		1								
1										
	1									
		1								
			-1							
			1							
				-1						
				1						
							-1			
							1			
										-1
										1
									-1	
									1	
					-1					
					1					
						-1				
						1				
								-1		
								1		
-2500(										
	-2500(									
		-2500(								

				Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	**Hire Labor** 2nd Q	**Hire Labor** 3rd Q	Health care costs 1st Q
0	0	0	1	0	0	0	0	0	0	0
								-1		
									-1	
				1						
					1					
						1				
							1			
1	1	1	1							
								-1		
									-1	

-15000(				18000(						
	-15000(				21000(				2500(	
		-15000(				18000(				2500(
			-15000(				21000(			

Health care costs 2nd Q	Health care costs 3rd Q	Health care costs 4th Q	cash transfer 1st quar-2nd quar	Cash transfer 2nd quar-3rd quar	cash transfer 3rd quar-4th quar	cash transfer 4th quar-end year		RHS	Resource Use	
0	0	0	482710.8	881279.4	1149331	2151348				
							< =	2.8	2.215837	Land
							< =	70	67.011309	MLabor 1st quar
							< =	70	70	MLabor 2nd quar
							< =	70	28.598644	Mlabor 3rd quar
							< =	70	11.278722	MLabor 4th quar
							< =	30	0.069345	FLabor 1st quar
							< =	30	6.979151	FLabor 2nd quar
							< =	30	3.252861	F Labor 3rd quar
							< =	30	8.123151	F Labor 4th quar
							< =	1	1	[redacted]
							< =	20	20	MTeenLabor1stQ
							< =	20	20	MTeenLabor2ndQ
							< =	20	20	MTeenLabor3rdQ
							< =	20	20	MTeenLabor4thQ
							< =	15	0.352718	MTeenLabor4thQ
							< =	15	4.976719	FTeenLabor1stQ
							< =	15	3.942106	FTeenLabor2ndQ
							< =	15	3.591412	FTeenLabor3rdQ
							< =	10	0.041607	FTeenLabor4thQ
							< =	10	2.353607	Kids Labor 2nd Q
							< =	10	0.412718	Kids Labor 3rdQ
							< =	10	3.325217	Kids Labor 4th Q
							< =	-1700	-1700	Maize Consump
							< =	0	-2.27E-13	Maize acctg
							< =	-1400	-1400	Manioc connsm
							< =		2.27E-13	Manioc acctg
							< =	-2	-2	Fruit Consump.
							< =		-60	Fruit Acctg.
							< =	-60	-60	Peanut Consum
							< =	0	7.11E-15	Peanut Account
							< =	-12	-12	Squash consum
							< =	0	-391.097	Squash Acctoun
							< =	-60	-60	Cowpea consum
							< =		-43.0977	Cowpea acctg.
							< =		-1.35E-13	Cotton acctg
							< =		-63	coconut acctg
							< =	-3	-3	coconut consump
							< =	-3	-3	MedplanConsum
							< =		-1.6E-14	Medplants acctg
			1				< =		-5.82E-17	Beg Cash 1st Q
			-1	1			< =		-1.16E-10	Beg Cash 2ndQ
				-1	1		< =		-4.42E-09	Beg Cash 3rd Q
					-1	1	< =		-9.78E-09	Beg Cash 4thQ
						1	> =	0	2151348.4	Tot Cash end yea

APPENDIX E

EARLY PUBLICATIONS ON GUARANI PLANTS AND MEDICINE

Among the most important authors and publications were:

Guillermo Piso (William Piso Van Cleff 1611-1678) was a doctor in medicine and naturalist. He is considered by some to have been the maximum authority on Guaraní Medicine. He came to Brazil where Tupí and Guaraní peoples occupied the coastal regions, with his collaborator Georg Marcgrav, a botanist brought by the Dutch governor Juan Mauricio de Nassau. They published "Historieae naturalis Brasiliensi" with many illustrations in Amsterdam in 1648 (Piso, 4 volumes), and "Historieae rerum naturalium Brasiliae" (Macgrav, 8 volumes). In 1658, Piso republished his works under the title " India Utriusque re naturali et Medica" without Macgrav's name. Guillermo Piso addressed the issue of syphilis in his book, calling it "bouba" and described remedies used for it in Brazil including purgatives, soporifics and decoctions for lesions based on the Jacaranda tree (*Jacaranda caroba*) and zarzaparilla (*Herreria zarzaparilla* = *Smilax* sp.). The Frenchman Andreas Thevet in "Historia dell'India America" (Venice, 1561) included data on Guaraní medicine (cited in González Torres, 1985).

Father Buenaventura Suárez wrote "Materia Médica Misionera" while he was working as an orderly in the Misiones region from 1702-1710. He also wrote "Indice Alfabético, Histórico-Médico de las Raíces, Arboles y Plantas Medicinales que se Encuentran en estas Provincias" (Historical-Medical Index of the Roots, Trees and Medicinal Plants Found in this Province). P. José Guevara attributed this work to him in his "Historia de la conquista del Paraguay." Suárez also published a book on lunar

his "Historia de la conquista del Paraguay." Suárez also published a book on lunar movement, which he studied from his observatory in the mission of San Cosme y Damián in present-day Paraguay. This book printed in the Misiones region, probably at Yapeyú or Candelaria in the early 18th century was used as a reference book in Europe (Martín y Valverde, 1995).

Perhaps the most important of these Jesuit writer proto-scientists was P. Pedro Montenegro who wrote "Libro de Cirugía Médica Trasladada de Autores Graves y Doctores para el Alivio de los Enfermos (1725)." But his principal work was "Libro Primero y Segundo de la Propiedad y Virtudes de los Arboles y Plantas de las Misiones y Provincias de Tucumán, con Algunas de Brasil y Oriente (First and Second Volume of the Properties and Virtues of the Trees and Plants of Misiones and the Province of Tucumán, with Some from Brazil and the East, 1710)." This book was illustrated with drawings of plants. There are extant several copies of this manuscript including one in Spain, and one in the Library at Buenos Aires. In 1888 it was published mistakenly by Trelles with the title "Materia Médica Misionera." There is a non-illustrated copy in the National Archive at Asunción dating from 1808. Undoubtedly, however, the finest copy is in Granada, in the hands of the guild "Hermandad Farmacéutica de Granada" (Fraternal Order of Granada Pharmacists) in Spain (Martín y Valverde, 1995).

A Jesuit named Segismundo Asperger wrote several books on medicinal plants. He created the famous Elixir of Misiones based on the aguará-yva plant (*Shinus* sp., *Terebentinaceae*) used for all types of maladies, as a depurative, for wounds and boils. This product was extensively exported to Europe.

P. José Sánchez Labrador S.J. wrote several books (1717-1798). He was uncommonly well trained in medicine, even by the diploma standards of his time. He lived among the indigenous peoples of the Oriental region and the Chaco.

The Jesuits –while being physically thousands of miles away – kept abreast of the latest European publications while they were simultaneously doing field work in the Misiones and other regions of South America. They were at the same time trapped in the rigorous mould of Church dictated thought, and amazingly open to new realms of knowledge (Martín and Valverde 1995, and González Torres 1985).

José de Guevara S.J. included in his works an "Indice Alfabético, Histórico, Médico, de las Raíces, Arboles y Plantas que se Encuentran en Estas Provincias (Historical, Medical and Alphabetical Index of the Roots, Trees and Plants that are Found in These Provinces)." He used Spanish and Guaraní names that he had learned during the years that he lived in the Misiones region (1733-1767.) He was commissioned to finish Lozano's "Historia del Paraguay." Lozano wrote on botanicals in chapters 8, 9 and 10 of this book, using his own knowledge and that from what he considers "serious authors." Chapters 11 through 14 were on zoology. In Lozano's book "Choreographic Description of the Gran Chaco Gualamba," chapter 4 is exclusively on plants and trees of the Paraguayan and Argentine Chaco and chapter 5 is on animals and serpents of the same area (Paris, 1825). His "Histoire des Plantes les plus Remarquables du Brésil et du Paraguay" was not published in Paris until 1924 (Martín y Valverde, 1995).

Nicolás del Techo wrote "Historia Provincieae Paraguaie Societatis Jesu" (probably printed in Misiones c. 1688, republished in Madrid, 1897) in which he uses three chapters to describe the flora of the River Plate Region.

Thomas Falkner (or Falconer), an English Jesuit who lived in Paraguay, Tucumán and the Pampas during 40 years wrote the very valuable "A Treaty of American Illnesses Cured with American Drugs" (pub. unknown, cited by González Torres, 1985).

"Flora Fluminensis Icones", a monumental work by Joaquín de Miranda Velloso, an eminent Brazilian doctor contains within its 11 volumes illustrated with 1776 ink plates many descriptions and uses of Guaraní plants. This work, while completed in 1790 was not published until 1815 by order of Don Pedro II, Emperor of Brazil. It was published in Paris after Velloso's death (González Torres, 1985[1]).

[1] Furlong, G. in *Misiones y sus Pueblos de Guaranies,* Balmes, Buenos Aires, 1962, and Armani, A., *Citta di Dio e Citta del Sole. Lo "Stato" Gesuita dei Guaraní, e de Studium,* Roma, 1977, also cite these works.

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BIOGRAPHICAL SKETCH

Norman Breuer Moreno was born in Montevideo, Uruguay, to Paraguayan parents. At one year of age he came to the United States where he spent his childhood in the snow and ice of Michigan. At age 14, he moved with his family back to their native, tropical country of Paraguay. He earned a degree in agricultural production engineering from the Universidad Nacional de Asunción. Afterwards, the business world awaited and he worked several years as a private agricultural consultant and spent a great deal of time in the Paraguayan countryside. It is there that he grew to love the simple things of the land and the people who live from and with it. Norman is married to Beatriz and has three wonderful children, Norman, Astrid and Erik.

In August of 2000, he will receive a master's degree in the Tropical Conservation and Development Program of the Center for Latin American Studies at University of Florida. Norman will continue his post-graduate work at the doctoral level in the Interdisciplinary Ecology Program of the College of Natural Resources and Environment at the same university. He hopes to research several aspects of development work, including farming systems research and extension applied to natural resource management, the nutritional aspects of medicinal plant use, and forest-based agrosilvopastoral systems for managing degraded forests.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts.

Peter E. Hildebrand, Chair
Professor of Latin American Studies

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts.

Ramachandran P.K. Nair
Professor of Forest Resources and Conservation

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts.

Hugh Popenoe
Professor of Soil and Water Science

This thesis was submitted to the Graduate Faculty of the Center for Latin American Studies, to the College of Liberal Arts and Sciences, and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Master of Arts.

August, 2000

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