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DIVERSITY, VARIATION, AND CHANGE IN RIBEREÑO AGRICULTURE AND AGROFORESTRY

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Ribereños, the native farmers of the lowland Peruvian Amazon region, subsist in an ecologically complex Amazonian varzea environment by practicing a highly diverse agriculture, and following individualistic agricultural strategies. A total of 14 different agricultural methods, identified as agricultural types, and the variation in agricultural strategies are described for two villages located at the Ucayali river. Diversity of swidden-fallow agroforestry on terra firme lands, and of varzea agroforestry is investigated. Ribereño agricultural diversity and variation in agricultural strategies can be explained as adaptations to the complex and dynamic conditions of the varzea. The case of ribereño resource use gives reason to question several theories that have been formulated about varzea resource utilization.

STELLINGEN

1

De diversiteit van ribereño landbouw in de varzea weerlegt Ross' stelling (The evolution of the Amazon peasantry, 1978) dat tegenwoordig boeren van het Amazone-gebied deze zone voornamelijk gebruiken voor extractieve doelen.

2

Ribereños voedingspatroon op basis van cassave en vis weerlegt Roosevelts theorie (Parmana: Prehistoric maize and manioc subsistence along the Amazon and Orinoco, 1980) dat slechts als gevolg van de introductie van maïs in het Amazone-gebied groepen met meer complexe sociale stratificaties zich konden ontwikkelen.

3

Ribereños onafhankelijke landbouw demonstreert dat er geen complexe sociale organisatie nodig is om landbouw te kunnen bedrijven in de varzea, en tevens dat onafhankelijke boeren efficiënter met de ecologische diversiteit en de onvoorspelbaarheid van dit gebied overweg kunnen dan georganiseerd opererende groepen.

4

De bereidheid van ribereños om, zoals ze gewoon zijn, riskante landbouw-produktiemethoden toe te passen, zal verminderen als de nu aanwezige mogelijkheden zullen verdwijnen om binnen een korte tijd de consequenties van mislukte oogsten op te vangen.

5

Agroforestry-systemen komen minder voor in varzea met haar vruchtbare bodems, maar worden daar intensiever beheerd dan die op de armere terra firme.

6

De ecologische complexiteit van de varzea en de landbouwdiversiteit van ribereños vereisen een landbouwplanning en -voorlichting die in eerste instantie gericht zijn op het verbeteren van de economische situatie van de landgebruikers, en pas in de tweede plaats op het optimaliseren van de produktie van het gebied.

7

De duurzaamheid van de landbouw is geen objectief meetbare eigenschap, maar een standaard die nog te weinig mede gedefinieerd wordt door diegenen van wie de huidige landbouw-produktiemethoden vaak als niet duurzaam beoordeeld worden.

8

Het gebruik van niet-hout bosprodukten kan een belangrijke bijdrage leveren aan de economische ontwikkeling van kleinschalige boeren, maar het is te verwachten dat dit slechts van gering belang zal zijn voor het behoud van niet of weinig verstoord tropisch regenwoud.

9

Het gebruik van systeemtheorie in de analyse van landbouw-produktiemethoden die direct en feitelijk beschreven kunnen worden, introduceert een extra abstractieniveau, wat in strijd is met de regel dat theorieën zo eenvoudig mogelijk dienen te zijn.

10

Vele proefschriften maken een fase door waarin ze voor een hele lange tijd bijna klaar zijn.

Wil de Jong. Diversity, variation, and change in ribereño agriculture and agroforestry.
25 oktober 1995.

A Carmen;

Esta obra te la dedico a tí, mi esposa, mi compañera, mi amiga. Al final de cuenta, es fé lo que nos hace alcanzar a los destinos que nos ponemos. La tuya ha sido mas grande de lo que podía esperar. Sin ella esta obra no hubiera sido posible.

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GLOSSARY

Acrisols	Strongly weathered soils with low CEC and base saturation similar to Ultisols; FAO/UNESCO classification.
Agente municipal	Village authority who represent the municipality to which the village belongs, and who is elected by the villagers.
Agricultural type	Unique site-crop combination which has a typical set of agricultural techniques, scheduling of activities, production levels, risk, and principal destination of output.
Aguajal	Forest which is dominated by the palm *Mauritia flexuosa*, probably an early succesional phase of varzea forest.
Amerindians	People belonging to native American groups.
Aquept	Soil which is saturated with water at some period in the year; Inceptisol suborder USDA classification.
Aquoll	Soils with the characteristic of wetness; Mollisol sub order USDA soil classification.
Ashaninka	Peruvian indigenous group related to Campas, living in the upper reaches of the Ucayli river and its tributaries.
Bank caving	Caving of the river bank or levees as a consequence of water erosion.

Bank-side shoaling	Formation of shoals, shallow places, along the river levees during high water level, which become mud flats or sand bars after the receding of the water during low water level season.
Barbasco	*Lonchocarpus nicou*, LEGUMINOSAE, a shrub, which contains rotenone, a natural insecticide, for which it was grown in the 1940s, but later replaced by factory produced substances.
Barreal	Mudflats, which are the deposits of silty sediments of the Ucayali and Amazon river which appear during low water level season.
Biotope	A micro environment with a relatively uniform land form, climate, soil, and biota.
Bora	Amerindian group, living in the border area between Peru and Colombia.
Caboclo	Rural people the Brazilian Amazon region, countrepart of Peruvian ribereños (see also ribereño).
Chacra	Swidden made on terra firme, and planted with a mixture of crops, but mainly with manioc.
Chiefdoms	Socio political organization of a tribal society ruled by chiefs with limited political power.
Cocama	Amerindian group living along the upper Amazon and Ucayali river, now largely integrated in the ribereño society.
Cocamilla	Amerindian group living along the Marañon river,

now largely integrated in ribereño society.

Conibo	Amerindian group living along the middle reaches of the Ucayali river.
Cowpea	*Vigna unguiculata*, LEGUMINOSAE, a pulse commonly planted on sand beaches (playas) in the varzea.
Debt-peonage	Work obligation which is emposed on laborers by debts they have incurred through the purchase of goods from the employer.
Fariña	Roasted manioc which was first gridded, washed, and dried.
Fluvent	Alluvial soils with very simple profiles; Entisol sub order USDA classification.
Fluvisols	Soils deposited by water with very little subsequent alteration; FAO/UNESCO classification.
Fundo	Large agricultural estates in the Peruvian Amazon, which appeared in the second half of the last century, but most of which had been abandoned by 1960
Gleysols	Poorly drained soils with mottled or reduced horizons due to wetness; FAO/UNESCO classification.
Illite	Clay sized soil mineral derived from mica, occurring in an environment of relatively high silica and alumina with partial stripping of potassium of interlayer.

I_{nmv}	Non managed vegetation index, used to measure the state of the weed vegetation in a forest garden field in order to assess the weeding pattern.
Lancha	Passenger and cargo boat of the type which commonly travels the larger Amazonian rivers.
Levee	Natural embankment, the result of deposits of sediments which are carried by the river.
Loreto	North eastern department, the largest administrative subdivision, of Peru.
Lovilla	Name of the small river which flows East of Santa Rosa, and which joins the Ucayali down stream from of the village.
Manioc	*Manihot esculenta*, EUPHORBIACEAE, a tuber crop widely cultivated in South America, but also elsewehre in the world.
Mayoruna	Amerindian group which inhabits the area between the Ucayali and the Yavari rivers.
Montmorillonite	Clay mineral with expansible layers, occurring in environments with high silica and alumina concentrations with slow moving or stagnant water.
Non managed vegetation index	See I_{nmv}.
Over-bank depositions	Deposits of sediment which occurs beyond levees adjacent to rivers.
Oxisols	Strongly weathered soils consisting of kaolinite, quartz and hydrated oxydes; order USDA classification.

Paleudult	Ultisol with old development in a humid moisture regime; great group USDA classification.
Playa	Sand beach, the result of deposition of the heavy sandy sediments carried by the river.
Point bar	Pointed sedimentation areas, caused by uneven deposition in a meandering river.
Pre-contact	From before the arrival of the Spanish conquistadores.
Puesto	Smaller estates found alongside the Ucayali or Amazon river which usually engaged in agriculture, but also extraction, trade, or firewood supply for steam ships.
Quichua	Amerindian group inhabiting the upper reaches of the Napo river
Restinga	Peruvian word for land on a levee, subdivided in high and low restinga.
Ribereño	Inhabitants of the Peruvian Amazon, most of which live along the larger rivers, and who are mostly small farmers (see also chapter three).
Ridge	See levee.
Runa	Amerindian group living in Ecuadorian Amazon.
Sand bar	Sandy deposits in the Ucayali or Amazon river, equivalent to playa.
Swale	Depression alongside a ridge or levee in the varzea landscape.

Swidden	Agricultural field which is the result of slashing a forest, or shrub vegetation, and which is intensively cultivated only for one or a few years.
Swidden-fallow	Fallow forest garden, the result of vegetation developed on land which was previously used as swidden.
Swidden-fallow agroforestry	Agroforestry of swidden-fallow, which most often are actively managed for fruits, pools or other products.
Tapiche	River which joins the Ucayali near Requena, and which was an important destination for produce from Yanallpa when rubber was extracted there.
Taungya	Land use system in which farmers are allowd to grow annual or semi-perrenial crops on land which has been planted to trees by a government agency, until trees are to tall to allow inter-cropping.
Teniente gobernador	Village authority, representing the government on the village level, elected by the villagers for a limited period.
Terra firme	Interfluvial uplands of the Amazon lanscape, mostly of Tertiary or Pleistocene origin.
Tropodult	Ultisol in a continually warm humid environment; great group USDA classification.
Ucayali	Together with the Marañon river one of the two main tributaries of the Amazon river.
Ultisol	Strongly weathered low base status, low CEC soils order USDA classification.

Varzea	Floodplain of the major rivers of the Amazon basin.
Yagua	Amerindian group inhabiting the border area between Peru, Colombia and Brazil.

PREFACE

This book is the product of an odyssey which began in 1982 when, as a doctoral student at the department of forestry, I left for Peru to do six months of field work, then a curricular requirement at the Agricultural University at Wageningen. The plan was to work in a project at the *Universidad Nacional de la Amazonia Peruana* (UNAP) in Iquitos. It wasn't clear what I was going to do there, but I figured that since I would at least learn the Spanish language, the trip would be worth while. On my return my father counted the time that I had been away from home: five years, eight months and eleven days. I had finished my studies at Wageningen by correspondence, and had worked at three local institutions in Iquitos, doing research in five different locations in remote parts of the Peruvian Amazon. My diploma had been waiting for me at the Agricultural University since 1984.

In my third job I was hired by Christine Padoch, from the New York Botanical Garden, who had started a research project on native fruits in the Amazon in collaboration with the *Instituto de Investigaciones de la Amazonia Peruana* (IIAP) in Iquitos. IIAP has a research station at the Ucayali river, the *Centro de Investigaciones Jenaro Herrera* (CIJH), and we were invited to join in the research on *ribereño* agroforestry in nearby villages. Our research results would provide the information based on which agroforestry trials were to be set up at CIJH. We started the research in 1985, and soon decided to expand its scoop to more general *ribereño* resource utilization.

The research on ribererño resource management contributes to two topics which are of scientific interest: resource management in the *varzea*, the floodplains of the larger Amazonian rivers, and resource management of non-tribal indigenous Amazonian people, a group which until recently had received little attention by anthropologists. The study appears in the midst of a post UNCED environmental euphoria, a time in which many ambitious plans for the sustainable development of Amazonia are being proposed. It is hoped that this work will provide useful baseline data for any of such endeavors.

A study like this only can be written with the help of many people and institutions. I wish to thank José Lopez Parodi, the director of the *Centro de Investigaciones Jenaro Herrera*, when I did my field work, and who allowed us to do research in his program. I also thank Ruperto del Aguila and Marcio Torres from the same center who assisted in the initial field surveys, as well as my several assistants in Santa Rosa and Yanallpa, in particular Pedro Revilla. Funding for the field work came from Swiss Aid to IIAP, and a grant from the Exxon Corporation to the New York Botanical Garden. I also wish to thank Michael Balick, director of the New York Botanical Garden's Institute of Economic Botany, who somehow magically found resources to allow me to come to New York and write this work. An additional writing grant was provided by the Homeland Foundation. Printing of this book was made possible with a grant from the Pro Natura Foundation.

More than to anybody else I owe thanks to Christine Padoch. She helped to think out the research, conceptualize the monograph, and took upon her the tedious task of reading the first drafts of the various chapters. She also took care of me when, sometimes, I felt lost in the vast jungle of New York. The monitoring of the writing was continued by Dr. Oldeman, who kept encouraging me to discipline myself scientifically during my time in Peru and while in New York, and who accepted me as a doctoral candidate. There are many people who have read, corrected, and edited the various chapters: Willa Capraro, Michael Chibnik, Robert Ewing, Elysa Hammond, Andrew Henderson, Paul Matthews, Judith Mayer, Marla Potess, Freerk Wiersum and Gail Wadsworth who gave the descriptions for the soils terms in the glossary. I thank you all very much for your patience and help. Last but not least, I want to thank the people from Santa Rosa, and Yanallpa, my friends, who shared with me their knowledge, their wisdom, their happiness, and sorrows. They often wondered about the purpose of my work, but never questioned it, and were never impatient with me bothering them. I miss their joy, and friendliness.

CHAPTER ONE

VARZEA RESOURCE USE: ECOLOGY AND HISTORY

INTRODUCTION

In most South American countries which have a part of their territory in the Amazon region, the aspiration persists of developing agriculture in the large areas of this un-exploited domain. An increasing number of scientists and developers consider the *varzea*, or floodplains of the larger rivers of the Amazon basin, as having great potential for such purposes (Parker 1981; Sanchez 1988; Nascimiento & Homma 1984; Denevan 1984; Bunker 1984; Smith 1982). The predominantly fertile soils of the varzea are thought to be promising for agriculture using modern methods, applying modern technology and fertilizers and pesticides. This expectation, however, is based on the belief that very few people actually live in the floodplain, that much of its land is under-utilized, and that indigenous agricultural techniques are incipient (e.g. Wagley 1953; Norgaard 1981; Petrick 1978; Denevan 1984).

Considering the myth of the potential for intensive agriculture which this ecological zone is supposed to possess, it is quite surprising how little is known about the Amazonian floodplain areas. Varzea ecology, for instance, is still very poorly understood. Major ecological studies of the larger South American floodplains did not appear until the last decade (Sioli 1984a; Withmore and Prance 1987), and basic ecological information on vegetation succession and river geomorphology is only now being produced (Lamotte 1990; Salo et al. 1986; Kalliola et al. 1987, 1988). The lack of information on indigenous land use practices in the various parts of the Amazon floodplains is even more surprising. Only a few dispersed groups of tribal Amerindians still live there. The larger part of the indigenous populations living in or close to the varzea, however, are *caboclos* in Brazil and *ribereños* in Peru. Chibnik (1991) qualifies these two groups as non-Indian, non-settlers. Caboclos as well as ribereños have mixed cultural origins of Amerindians, Europeans, and immigrants from other parts of South America (Parker 1985; Padoch 1986). Ethnographers working in the Amazon have been more interested in tribal Indian groups located in remote terra firme areas, or the vast interfluvial upland areas of the basin, and they have ignored the large non-tribal river populations. Consequently most studies on indigenous resource management practices in Amazonia have been pursued in the same habitat. In fact, since substantial archeological research has been done in the varzea, more has been written on pre-contact floodplain resource management practices than about contemporary use.

This book presents a case study on resource management of ribereños in the Peruvian Amazon, a large part of which takes place within the floodplain. The complex agricultural and agroforestry practices of the inhabitants of two villages, namely *Santa Rosa* and *Yanallpa*, located on the lower Ucayali river will be discussed. This study will provide new information on varzea resource utilization, but its findings also have implications for several of the theories proposed about varzea resource management in general. For instance, the fact that most ribereño agriculture is located in the floodplain contradicts other researchers (e.g. Ross 1978) who think that Amazonian peasants only use the varzea for extractive purposes. The fact that ribereños operate as independent farmers challenges theories which say that a complex social organization is required to make agriculture possible in the Amazonian floodplains (Meggers 1971). The agricultural diversity among ribereño farmers contradicts Roosevelt (1980) who states that pre-contact varzea groups could not produce sufficient manioc in the floodplain, or obtain sufficient protein from fishing to adequately feed themselves, and therefore must have relied largely on seed crop production.

In this introductory chapter the most important facts and ideas that have been written on varzea resource management will be summarized. It will briefly anticipate the way in which this study will contribute to the understanding of varzea resource management, and how some of its findings question several of the ideas which have been formulated regarding past and present varzea resource use.

VARZEA ECOLOGY AND LAND USE

The division of the Amazon lowland region, the area enclosed by the Guiana Shield, Central-Brazilian Shield, and the Andes (Putzer 1984), into two ecological zones, terra firme and varzea, is largely based on their different geomorphological history. Terra firme is the land of the Amazon basin above flood level (Klammer 1984), and this includes most of the basin which is of Tertiary and Pleistocene origin (Irion 1984; Putzer 1984). The term varzea is used only for the seasonally inundated floodplain of the Amazonian white water rivers. Varzeas include the entire area between the rimming valley walls, or interfluvial lands, in which the river flows across recent alluvium, and in which it changes its channels (Prance 1979; Denevan 1984). Varzea soils are alluvial deposits of much later date than soils of terra firme (Roosevelt 1980).

The Amazon river is divided into lower, middle, and upper Amazon (e.g. Parker 1981; Sioli 1984b). The varzea of the lower Amazon, or the *varzea de mar* as Parker (1981) calls it, is subject to periodic flooding caused by tidal influences of the Atlantic ocean. Subsequently, ecological conditions are different between the floodplains of the lower Amazon, and the varzeas of its middle and upper reaches which are subject to periodic flooding caused by the yearly oscillation of the river level (Parker 1981; Sternberg 1975; Petrick 1978; Sioli 1984b). The following discussion deals only with the latter varzea areas.

Sternberg (1975:10) calls terra firme and varzea "two basically different groups of landforms", indicating not only the differences between the two zones, but also the ecological pluriformity of each. The two principal processes which account for the ecological complexity in the varzea are erosion and sediment deposition. Erosion of the river banks, which mostly consist of previously deposited sediment (Sioli 1984 b), is mostly in the form of bank caving. Deposition may occur within the channel by bank-side shoaling resulting in muddy or sandy beaches, or as over-bank deposition which results in the formation of natural levees. Sometimes building up of levees and eroding of the river bank may occur on the same sites, but during different periods of the year (Sternberg 1975). In the Ucayali concave banks are being eroded (Lamotte 1990).

The complex geomorphological dynamics of the Amazonian white water rivers create a complex landscape in which Denevan (1984: 314) distinguished a total of 9 different landforms. The most important landforms, also found in the Ucayali environment, are natural levees, point bars, and sand or mud beaches. Since the upper Amazon, Ucayali, and Marañon rivers are meandering, and not braided like the middle and lower Amazon (Goulding 1980; Sioli 1984 b) the shifting of the river channel here is faster than in the lower parts. Subsequently, varzea lands in these regions are subject to much faster changes (Parker 1981; Goulding 1980; Denevan 1984). In the Ucayali deposits of more than one meter resulting from one flooding season could be observed, while in some places the river channel shifted laterally up to 50m in a single year.

The floodplain geomorphology results in a varied pattern of soil quality and fertility, and in a varied periodicity and length of inundation. Consequently it contains various landforms and therefore many diverse options for its land use (Hiraoka 1985a,b; Bergman 1980; Denevan 1984). Denevan (1984) proposes a typical sequence of floodplain crop production which follows the topographical varzea gradient from the river side to natural levee to permanently flooded backswamps. On the mud or sand bars rice and beans are grown. On the levee foreslopes maize, sugarcane, and jute are the most appropriate crops. Bananas, manioc, and orchard gardens are found on the tops of the levees. On the back slopes jute and sugar cane can be grown, while beans, along with pasture, are found in the backswamps.

PRE-CONTACT VARZEA RESOURCE USE

An evaluation of contemporary indigenous varzea resource use is often based on its comparison with pre-contact (i.e. before the arrival of Europeans in the Amazon) resource use. The indigenous population which lived near the varzea when the Europeans first entered the Amazon region experienced more dramatic cultural changes than most terra firme groups (Denevan 1976; Meggers 1971). The introduction of alien diseases devastated most varzea societies and disrupted their way of life (Denevan 1976). Slave raiding by the Portuguese since the early seventeenth century and the establishment of colonies by missionaries also had great influence on the riverine people. After the expulsion of the Jesuits from South America in 1767, a new mercantile interest in Amazonia emerged and this intensified the exploitation of the indigenous population (Ross 1978; San Roman 1975; Parker 1981; d'Ans 1982). Finally the rubber boom, which lasted from about 1870 until 1920, saw large groups of tribal and non-tribal local people being mercilessly exploited.

Using reports from early travelers (e.g. Carvajal, Acuña, and Fritz), Meggers (1971) provides a brief description of the Omagua, a group living in large and dense populations in the Amazon floodplain between the mouth of the Japuri river and midway between the Coari and Purus rivers. From the reports it appears that they were organized into chiefdoms with well developed hierarchical authority structures. The floodplain habitat provided these people with large quantities of game, fish, and agricultural products, which were obtained with very little labor expenditure. Bitter manioc and corn were grown as the principal staples, together with numerous other crops.

Roosevelt (1989) further investigated pre-contact varzea resource use patterns and distinguished four different evolutionary stages in prehistoric resource management in Amazonia. The first people who entered the Amazon lived as hunter-gatherers (1989: 40), followed by semi-sedentary occupations of people who may have practiced primitive horticulture (1989: 43). The third evolutionary stage in varzea resource use patterns is that of early horticultural villagers. This stage, according to Roosevelt, resembles the present-day indigenous varzea patterns, and it is characterized by reliance on fish, game, and starchy root crops (1989:45). The increase in population which began several centuries before Christ, led to the last phase, that of the agricultural chiefdoms.

Roosevelt bases her distinction of the four stages on archeological and ecological evidence. In an earlier publication (1980) she argued that the large populations who inhabited the floodplains during contact subsisted on seed crop production of corn and pulses, and not on a diet of fish with manioc. This subsistence pattern lasted until the native societies were destroyed as a result of contact with Europeans. During high water periods, according to Roosevelt, fish catch levels are too low to supply sufficient protein for varzea populations living in densities as high as the pre-contact groups. Roosevelt (1980: 125) furthermore argued that manioc is an inadequate staple for the floodplain. Manioc varieties do not yield significant production in less than six months. Since, according to Roosevelt, most varzea soils are flooded for half of the year and remain waterlogged for some time longer, manioc can only be produced during a few months in the floodplain. On the contrary, corn can easily be grown in the varzea, as its growth cycle is completed within four months, and the produce can be stored for the rest of the year. Corn contains proteins which, when supplemented with proteins from pulses, provide all basic amino acids. Thus, according to Roosevelt, the chiefdoms could only develop as a result of shifting to subsistence on seed crop production. The chiefdoms did not rely on fish and manioc as their principal calorie and protein resources, as was thought previously by Meggers (1971) or Denevan (1976).

Meggers, as well as Roosevelt, argue that the pre-contact groups subsisted in the varzea only because they were able to organize their resource management calendar adequately. The high flood season required that sufficient food was harvested and preserved during low water to bridge the flood-period scarcity of supplies, especially in protein. The unpredictability of the flooding regime required a tight scheduling of activities. Both these factors demanded that labor was organized strictly so that labor groups could be allocated to different types of work at the most appropriate moment. The hierarchical social organization of the pre-contact chiefdoms made this possible (Meggers 1971).

CONTEMPORARY VARZEA RESOURCE USE

Research on contemporary varzea resource use started with a few notable studies. One of the few Indian groups that has persisted in the floodplain and has maintained its ethnic identity are the Shipibos in Peru. A detailed description of their resource management practices has been given by Bergman (1974, 1980), who provides many data on the use of ecologically different sites, agricultural techniques, labor input, and economic returns. The fertile varzea soils and rich aquatic resources allow Shipibo farmers to "provide an excellent diet" while only working between one and three hours per day (Bergman 1980: 288). The principal staple, however, is plantain, which produces a higher caloric return per labor input than manioc.

Wagley (1953) briefly describes caboclo subsistence in a study of a Brazilian town on the Amazon river. The caboclos, according to Wagley, grow some corn, rice and beans in the floodplain, but their main agricultural activity is manioc production in terra firme fields. However, agriculture does not yield sufficient cash income, and most caboclos are therefore involved in extractive activities as well. The most important of several collected forest products is rubber (*Hevea brasiliensis*). Other authors give similar descriptions of the caboclo's main focus on terra firme manioc production together with extractive activities in the varzea (Parker et al. 1983; Frechione et al. 1989; Norgaard 1981; Petrick 1978; Barrow 1985). The floodplain, according to the same authors, is not significantly used for agriculture.

Ross (1978) tries to explain the difference between the well developed varzea resource exploitation of the pre-contact groups, and the virtual absence of agriculture among contemporary floodplain inhabitants. He argues that in the process of acculturation of the indigenous varzea population, much of the knowledge and skill required to benefit from the varzea environment has been lost. Tribal organization could not be maintained, and varzea dwellers could not practice any significant agriculture since they had little time left from their extractive activities. Ross also stipulates that the caboclos' solitary existence is the most important factor which prevents them from practicing varzea agriculture, and their lack of a social structure excludes the organized labor, required to cope with the constraints involved with varzea agriculture, especially its high risks. Fluctuation and unpredictability of flooding add a risk factor to varzea agriculture, which is absent on terra firme.

Thus Ross reasons, although soil fertility is higher in the floodplain, caboclos prefer to farm terra firme to avoid this risk. Although in some localities in Brazil caboclos have returned to the floodplain to start growing jute, or rice (Wesche 1985; Bahri 1988; Guillaumet et al. 1990), many still hold that floodplain exploitation is virtually absent.

RIBEREÑO HISTORY

It has been emphasized repeatedly that the non-tribal indigenous population of the Amazonian floodplains received insufficient attention from the scientific community (Parker 1985; Padoch 1987). This explains partly why many aspects of varzea resource use are still poorly understood. Only recently, major publications on caboclos have appeared (Parker 1981, 1985). Extended research projects on caboclo resource management practices have been carried out in the Amazon estuary region (Anderson et al. 1985, Parker 1981), but only minor studies have been conducted in the mid Amazon region (Frechione et al. 1989; Parker et al. 1983). Only a few recent studies focus on caboclo varzea agriculture and agroforestry close to Manaus (Bahri et al. 1991; Guillaumet et al. 1990). Studies on the Peruvian Amazon have focussed on specific aspects of its history (d'Ans 1982; Golob 1982), although only a few include a discussion of the twentieth century (San Roman 1975; Meyers 1988). Ribereño resource use practices are briefly discussed by Hiraoka (1985a,b), Padoch et al. (1985), and Padoch & de Jong (1987, 1989). Chibnik and de Jong (1989) discuss the ribereño labor organization. Chibnik (1990) evaluated risk and uncertainty in ribereño rice production, and he also made an attempt to give a more precise characterization of the several "quasi-ethnic groups", or locally born non-Indians of Amazonia, including caboclos and ribereños (Chibnik 1991).

Padoch (1986: 4) defines ribereños as "a rural mixed population of detribalized Amazonian natives and their descendants, former immigrants from neighboring Peruvian Departments of San Martin and Amazonas and their descendants, the children and grandchildren of immigrants from other South American countries as well as from overseas, and the descendants of any unions between members of the above groups. Very few are recent immigrants, and virtually none are from non-tropical environments". Ribereños are the largest group of rural inhabitants of the lowland Peruvian Amazon region, who live mostly along the major rivers (Aramburu 1984). The small villages called *caserios* are isolated and usually can only be reached by boat. Most ribereños make a living as agriculturists, but many also extract forest products or work as wage laborers or traders to obtain cash income (Padoch 1987). Ribereño agriculture is, for a large part, located in the varzea and combines production for household consumption with intensive cash cropping.

The history of the ribereño people and culture is similar to the one described for the Brazilian caboclos. Both histories are largely determined by economic events in the region (San Roman 1975; Padoch 1987; Padoch & de Jong 1989). During the period before the rubber boom, until about 1870, the impact of slave raiding, forced migrations, and debt peonage on the indigenous river population in Peru was less than in Brazilian Amazonia. However, during the rubber boom the Peruvian natives also experienced influences which, in many cases, totally disrupted their social organization, economic activities, and even cultural identity. According to Chibnik (1991), the crucial period of the formation of ribereño identity was between 1910 and 1950, about 100 years after the emergence of the caboclos as a cultural group. In general, more traces of Amerindian culture still persist among these Peruvian riverine people than among the caboclos.

RIBEREÑO RESOURCE USE

During the rubber boom, much agricultural production in the Peruvian Amazon was abandoned, since large contingents of farmers and farm laborers became involved in extractive activities. After the rubber boom, however, agriculture was reestablished but in the form of larger estates or *fundos* to which most native Indian and ribereño populations became attached as laborers (Higbee 1945; San Roman 1975; Padoch & de Jong 1990). Besides agricultural production, the fundo owners engaged with their labor forces in extractive activities every time that certain forest products were in high demand in the international markets (Padoch 1987; Padoch & de Jong 1990). Beginning in the early 1960s more and more fundos collapsed, and their owners left. Previous laborers on these estates stayed behind and became independent farmers.

Hiraoka (1985a,b, 1986) shows how ribereño farmers use sites in the floodplain which are ecologically very different from one another. These sites can only be planted with certain crops and require specific farming techniques. He reports on a total of 14 *biotopes* which the inhabitants of a village close to Iquitos each use for specific purposes. A biotope is defined by Denevan (1984: 311) as a micro-environment with relatively uniform landform, climate, soil, and biota. The biotopes which are mostly used for agriculture are located on natural levees, on river islands, and on sand and mud bars. A total of six biotopes are used for agricultural production. These include the top, foreslopes and backslopes of the natural levees, mud and sand bars, and river islands. According to Hiraoka (1985 b: 252), in the yearly flooded biotopes seasonal agriculture is practiced, while on the levee tops a short fallow agriculture with semi-perennials and perennials is carried out. Different biotopes can be planted to different crops, require different agricultural techniques, and produce different yields.

RIBEREÑO AGROFORESTRY

It is now generally acknowledged that practices which can be qualified as agroforestry are common among many Amazonian tribal and non-tribal farmers (Posey 1983; 1984, 1985; Denevan et al. 1984; Denevan & Padoch 1987; Anderson 1990; Anderson & Jardim 1989; Anderson et al. 1985; Padoch et al. 1985; Padoch & de Jong 1987; 1989; Hiraoka 1986; Irvine 1987; 1989; Bahri et al. 1991; Guillaumet et al. 1990). However, agroforestry practices among indigenous Amazonians have dissimilar characteristics and provide a range of different products and services. The variation of agroforestry practices in, for instance, an area like the Peruvian Amazon region around Iquitos is considerable (Denevan & Padoch

1987; Padoch et al. 1985; Hiraoka 1986; Padoch & de Jong 1987). Both household and market oriented agroforestry practices have been reported for ribereño communities (Padoch et al. 1985; Hiraoka 1986; Padoch & de Jong 1987; 1989). Not only do these systems differ in destination of the output, but also in species composition, complexity, and management patterns. Agroforestry practices of local farmers who are more involved with regional economies are suggested to present more useful models for resource use planners than those found among remote tribal communities (Padoch & de Jong 1987: 193).

RESEARCH QUESTIONS AND RATIONAL

This book will explore answers to the following questions :

(1) How diverse are the agricultural practices among ribereños?
(2) What are the specific characteristics of different agricultural practices?
(3) How variable are agricultural strategies among farmers within single villages, and between villages?
(4) How can the variation in agricultural strategies be explained?
(5) How common and diverse are agroforestry practices among ribereños?
(6) How do agroforestry practices differ between villages?

Although studies by Hiraoka (1985a,b; 1986; 1989a) have shown some of the complexity of ribereño agriculture, much quantitative data on specific agricultural methods found among ribereños is lacking. As a consequence, conclusions like interpretation of the relationship between biotope diversity and land use, or the distinction between agriculture in seasonally flooded and non-flooded varzea lands still needs to be investigated further. After a discussion of the methodology in chapter two, and an introduction to the research area, villages, and people in chapter three, in chapter four a detailed discussion of the diverse agricultural practices of ribereños will be presented. This chapter will demonstrate that, although short fallow swiddening does occur on higher levees (Hiraoka 1985 b), this is not the only type of land use found there. Furthermore, on sites of the lower varzea the soil quality, elevation, and subsequent yearp ly flooding varies. As a result, ribereño farmers ceaselessly modify the kind of agriculture, adapting it to different sites. Finally it will also be shown that land use on the same site varies from year to year as a response to changes in ecological and economic conditions.

In chapter five variation and changes in agricultural strategies of ribereño farmers will be investigated. Agricultural strategies can be defined as choices concerning agricultural activities, which farmers have to make in regards to the allocation of limited resources (land, labor, capital) in order to meet their subsistence needs. In general, studies on agricultural strategies explain agricultural behavior of certain groups of farmers (Barlett 1980a). It is also true that agricultural practices of many traditional societies change in response to internal or external influences (Padoch 1982; Roseberry 1989; Cancian 1989). Both variation in agricultural strategies and changes in these strategies demonstrate adaptations to certain ecological or socioeconomic environments.

As will be shown in chapter five, the complexity of ribereño agriculture is partly a result of the variation in agricultural strategies. In addition to long term changes of ribereño life and livelihood due to increased contact with the outside world (Hiraoka 1985 b: 265), ribereño agriculture is characterized by a flexibility which is reflected by changes over short periods. Both variation in agricultural strategies and flexibility in resource management are related to the dynamic environment in which ribereños live. Not only are the land forms ecologically diverse, but they may also appear and disappear overnight. Market opportunities may change completely within a very short period. To adapt to those changes, ribereño farmers modify their agricultural strategies profoundly. The data presented in chapter five will demonstrate that the variation in ribereño agricultural strategies, as well as the profound short term changes in these strategies, are adaptations to the highly diverse and highly dynamic ecological and economic environment of the floodplain.

In chapter six siwdden-fallow agroforestry in the village of Santa Rosa, and in chapter seven varzea agroforestry in Yanallpa will be discussed. Although studies on Amazonian ribereño agroforestry indicate that a variability exists within single systems usually reported for separated villages, this aspect has not yet been thoroughly investigated. Padoch & de Jong (1987) previously indicated that among farmers within single villages agroforestry practices may be different. Since agroforestry practices are common in the Peruvian Amazon, agroforestry options are apparently available to ribereño farmers, but not all will opt for the same systems. Understanding this phenomenon will increase the knowledge of the potential for developing agroforestry systems for this and possibly other regions.

THEORIES ON VARZEA RESOURCE MANAGEMENT QUESTIONED

The results of this study question several of the above outlined ideas on varzea resource use.

Ribereño agriculture is in remarkable contradiction to the supposed absence of caboclo agriculture in the varzea, as reported by Wagley (1953), Ross (1978), and Frechione et al. (1989). This contradiction requires an explanation. The main constraints to varzea agriculture are risk of field flooding, and the limited time available for cropping varzea lands. The several agricultural methods which ribereños apply differ in labor requirements and scheduling, destination of produce, yield level, and risk. By developing numerous agricultural methods, and by combining those in single farm enterprises, ribereños succeed in lowering the overall risk and make better use of their available labor. This indicates that agricultural diversity, variation in agricultural strategies, and agricultural flexibility are adaptations to the constraints of the varzea environment. Although many ribereño farmers combine varzea and terra firme agricultural production, it is possible to rely only on exploitation of the varzea environment.

The example of the ribereños invalidates the argument of Ross (1978), that caboclos do not farm the varzea because they are unable to coordinate their subsistence activities.

Ribereño varzea utilization furthermore contradicts the need of persons of higher status to coordinate labor among pre-contact groups in order to provide an adequate agricultural calendar (Meggers 1971; Roosevelt 1980). Even in areas of high population densities, ribereños operate independently. Organized labor groups and festive labor parties are common among ribereños (Chibnik & de Jong 1989), but many farmers do not participate in them, and they are not indispensable in varzea farming. Hiring laborers is generally avoided by ribereño farmers, and it only occurs for certain cash crop activities (Chibnik pers. com. 1991). Operating as an independent farmer appears to be a more appropriate way of coping with the tremendous diversity and dynamics of the varzea environment, rather than operating in larger hierarchical groups.

The agricultural diversity of ribereños also contradicts Roosevelt's (1980) hypothesis concerning the seed crop based subsistence strategies of pre-contact groups. In chapter four it will be shown that the production of corn and manioc are not at all incompatible in the floodplain. However, the rate of return for protein per unit of labor for a corn crop is not nearly as high as protein yields obtained by fishing, even during high flood (Bergman 1974). Therefore, the example of sustained floodplain use by ribereños invalidates the theory that larger pre-contact populations could develop only because they changed to a seed based diet.

CHAPTER TWO

METHODOLOGY AND METHODS

INTRODUCTION

Indigenous agriculture has been studied by scientists from many backgrounds. Researchers have emphasized different aspects according to their particular disciplinary orientations (Spencer 1966). While more orthodox agricultural scientists have focussed on mechanical and biological aspects of agriculture, other scientists like agricultural economists, economic anthropologists, geographers, and rural sociologists have been more interested in socioeconomic aspects of small scale farming. How diverse the specific aspects of agricultural practices can be is shown by Conklin (1963) who provides a long list of different research themes that can be selected when studying shifting cultivation. As a result, little methodological uniformity exists in research on traditional agricultural systems.

A scientific approach to indigenous agriculture which has received more interest recently is the systems theory model. Fresco (1986) used this model when studying shifting cultivation in Zaire. Fresco distinguished different system levels, defined as suprasystem and subsystems, the most important of which are regional systems, farming systems, cropping systems, and crop systems (1986: 47). To conduct her analysis, Fresco defined a number of observation units for each system level and specified a set of variables for each unit. This resulted in a separate set of data for each system level. Data was derived from various primary and secondary sources.

A different approach has been followed in studies which are within the rural sociology or economic anthropology disciplines. In earlier anthropological studies, attempts have been made to demonstrate the uniqueness of certain people as a social group (Cancian 1988), or to investigate whether or not economic models applied in western societies could be used in non-western societies (Plattner, 1988; Roseberry 1988; Johnson 1980; Chibnik 1990; Barlett 1980b). However, since the 1970s students of peasant agriculture have become concerned with agricultural development issues (Barlett 1980b: 1) and have searched for answers to research questions similar to those formulated in the present study. Many economic anthropological studies investigated how variable natural, social, political, and economic conditions influence the agricultural strategies of farmers (Barlett 1980a). Which conditions are important and, therefore, need to be investigated, depends not only on the agricultural systems under study, but also on the questions which are asked. In Barlett's words (1980a: 549-550) "The wide range of variables that affect production strategies derives not only from the complexity of choices but also from the diverse research problems that have been addressed."

The consequence of such an axiom is that even if one accepts the systems theory approach, it is still the specific research questions that determine what information is needed and how that information is generated. This assumes that certain practices or processes have their own rationale or causality, which can be understood by relating different phenomena in terms of cause and effect. This is the same approach that system theory uses. A system theory approach divides the realm of a certain people as far as it relates to their agriculture into different system levels. However, the causality of the phenomena described remains the same. This, in fact, means that using systems theory is not a *conditio sine qua non* to find answers to the questions formulated in chapter one.

In retrospect, the following research strategy was followed for this study. First it was necessary to decide which data needed to be collected. Second, research units were selected, and the variables that had to be quantified were defined. Finally, methods were chosen for the gathering of data. The present chapter describes this process, and the methods that were used to conduct the research.

DEFINITION OF CONCEPTS

A number of concepts are important in this book. In the previous chapter *agricultural strategies* was defined as *choices which farmers have to make as to* *the allocation of limited resources (land, labor, and capital) to meet their subsistence needs, and as far as these concern agricultural activities.* A second concept, discussed in chapter four, is agricultural diversity. *Agricultural diversity* can be defined as *the combination of different agricultural methods used by a specific, but delimited group of farmers*. A third concept, called the agricultural type, is also proposed in chapter four. An *agricultural type* is defined as *a unique site-crop (or crop mixture) combination, which has a specific set of agricultural techniques, scheduling of activities, production levels, principal destination of output, and risk.* A fourth important concept used in chapters four through seven is management. Management as an agricultural activity is a more general term than cultivation. *Management* can be defined as *actively and purposely influencing the development of vegetations, be they planted or spontaneously occurring individuals of a species, in order to derive a certain benefit from this specific vegetation.* Management therefore covers the intellectual agricultural decision taking, as well as the carrying out of a number of cultivation activities such as harvesting, clearing, burning, planting, and weeding or clearing the direct surroundings of individual plants.

SCHEDULING OF THE RESEARCH

As the first methodological decision, it was chosen to conduct a long-term study among farmers in two ribereño villages. Since the study was to be part of the research program of the *Centro de Investigación Jenaro Herrera*, the research sites had to be chosen from those villages located in the area in which this center conducts its research (Lopez 1982). This area extends along the Ucayali river approximately between the town of Requena and its confluence with the Amazon (Figure 3.1). In April 1985, the several collaborators of the project conducted a general survey of the villages in the area in order to identify study sites. In each village a few farmers were interviewed about the most common agricultural practices in their community. Santa Rosa and Yanallpa, which were chosen as research sites, represent two different types of ribereño villages. The most important difference is their location. Santa Rosa is located on terra firme, while Yanallpa is completely located within the varzea. Each of the two village types will be discussed in chapter three. Since both Santa Rosa and Yanallpa are located at about the same distance from Requena, the regional market and administrative center, it was expected that market opportunities would be roughly the same in the two villages. Field work was started in Santa Rosa in June 1985, and in Yanallpa in May 1986. After September 1986 most field work was carried out in Yanallpa, and only short visits were made to Santa Rosa about once a month. The field work was concluded in August 1987.

In both villages an initial exploratory period provided an opportunity to become familiar with the people, the area, and the many different subsistence activities. During that period, farmers were joined in their daily activities and many were interviewed when there was opportunity to do so. This allowed familiarization with the villagers and their agricultural fields, and resulted in much unstructured information about resource management. The specific research activities and methods were developed largely on the basis of this understanding of the people and villages acquired during the initial period.

SELECTION OF RESEARCH UNITS

Although in research on indigenous agriculture the family or farm household is often chosen as the basic unit of study (Barlett 1980 a; Wiersum 1988; Marten & Saltman 1986), single households in Santa Rosa and Yanallpa sometimes consisted of more than one economic unit. For instance, different families could live together temporarily, or family members might be on their way to becoming independent farmers. If more than one member claimed to have his or her own agricultural fields within a single household, they were each distinguished as a separate farming unit. Such separate ownership became apparent when members of a household were questioned about the fields they possessed. Thus, the farming unit was selected as the first research unit. In the rest of this book whenever the term farmer is used, it refers to such an independent farming unit.

The agricultural field was chosen as the second research unit. The distinction and classification of agricultural types, as discussed in chapter four, is based on a survey of many single agricultural fields. The assessment of diversity in agroforestry practices in chapters six and seven is also based on the comparison of many single forest gardens or varzea agroforestry fields.

DATA GATHERED AND RESEARCH METHODS

Members of farming units were interviewed in order to gather information about agricultural strategies and other economic data on their farm enterprises. A list of questions had been made before starting the interviews, and these were asked during each interview. One or more members of the farming unit were questioned; in most cases this included the head of the family. If the family head could not be located than another member of the farming unit who appeared to be knowledgeable about agricultural matters was interviewed. Inquiries were also made about economic activities other than agriculture (e.g. fishing, trade, transportation of goods) since this was expected to explain at least partly, why farming units had certain agricultural strategies.

Whenever a farmer mentioned special circumstances or practices during the interview, questioning was directed toward that particular subject. The interviews, therefore, did not merely follow the questionnaire, but rather were standardized in-depth interviews. Thus, although a specific list of questions was asked of each farmer, often additional information was also obtained in informal conversations. For example, when a farmer had just made a new agricultural field, an inquiry was made into how much labor had been used for preparation or planting. Some interviews lasted up to two hours. Most of the interviews in Santa Rosa were done during October and November 1985. Some farmers were difficult to locate, and had to be interviewed later. In Yanallpa the interviews were conducted between September and October 1986.

The information needed for the characterization of agricultural types was also gathered through participant observation and interviews, as well as note-taking by a few farmers. Data concerning agricultural types were gathered during the entire research period. Many farmers were interviewed several times, often through informal conversations. Farmers were accompanied to their fields and the researcher often participated in labor parties or collaborative work days. Once the distinction of agricultural types (see chapter four), was made, the interviews with farmers became more specific. Before starting the interviews in Yanallpa, many agricultural fields were surveyed again to adjust the classification of varzea agricultural types.

In both villages a number of forest gardens were selected to study the diversity in agroforestry practices. Fields selection was based on differences in species composition, age, and management pattern. A detailed description of each field was made, including its exact location, topography, and vegetation. The land use history, as told by the current owner or other informants, was recorded. In most cases, these went back as far as the first use of the fields. A transect method was chosen to sample fields (e.g. Richards 1952; Whitmore 1984; Hallé et al. 1978; Michon 1985; Guillaumet et al 1990).

The transects used in forest gardens were 30 m wide. This is wider than used in most other similar studies (e.g. Irvine 1987; Denevan & Padoch 1987; Michon 1985). In previous research only 10 m wide transects were used (de Jong 1984), but this can be considered an insufficient sample size for fields with as much spatial variation as displayed by the forest gardens in Santa Rosa and Yanallpa. Some of the varzea fields were too small to make 30 m wide transects. In these cases only 20 m wide transects were used. It was attempted to include major ecological gradients in the transects, in most cases the maximum slope of the field. Transects were subdivided into 10x10 m^2 subplots.

In forest gardens a distinction was made between managed and non-managed vegetation. Each adult individual of a domesticated plant species was considered as managed (e.g. Vasquez 1990; Calzada Benza 1981, Cavalcante. 1976, 1978, 1980). If natural regeneration of a domesticated tree species occurred, and there was no clear indication which plants were actually managed, then only individuals higher than 1 m were considered to be managed. In addition to domesticated plant species, ribereño farmers protect many native forest species, most often in forest gardens (Padoch & de Jong 1987). Individuals of a non-domesticated species were considered to be protected if the vegetation surrounding such plants appeared to have been recently cleared, or if they grew in an unusual habitat. An example of the latter, for example, was seen when a species from the varzea was grown in terra firme. This indicated that the owner had deliberately saved the plant from weeding, or cleared it of surrounding vegetation. In several cases the owner of the field was asked if specific plants were protected or not. All the managed plant individuals in the transects were mapped, providing data on densities of managed species in the forest gardens. Spatial patterns of the studied forest gardens will not be discussed in this book.

An important variable used for the comparison of the management of forest gardens in Santa Rosa is the weeding pattern of fields. To estimate weeding patterns of terra firme fields an Index of Non-managed Vegetation (I_{nmv}) was used. Every three months the non-managed vegetation in each 10x10 m^2 subplot of the transects was estimated by attributing to it an I_{nmv} value ranging from 1 to 5. The weeding pattern of any terra firme agricultural field is reflected by the state of the non-managed or weed vegetation. The weeding patterns of four of the seven forest gardens was compared by estimating the state of the non-managed vegetation every three months for a total period of 18 months. In three other fields this observation was not possible. Two fields were slashed soon after the inventory was carried out, and one field was located too close to the village to allow the making of a permanent plot.

I_{nmv} values from 1 to 5 have the following meanings:

I_{nmv} value 1 indicates that the non-managed vegetation is virtually absent, or less than 20 cm high in the whole 10x10 m^2 subplot. The weed vegetation is heel high, the field has been newly made or recently cleared.

I_{nmv} value 2 indicates that weed vegetation of a height between 20 cm and 50 cm covers more than 50% of the subplot. The weed vegetation is not more than knee high. Although such weeds are competitive to crops (Tripathi 1977; Crossley et al. 1984), Santa Rosa farmers do not perceive this state of non-man-

Table 2.1: I_{nmv} (non managed vegetation index) values used to estimate weeding patterns in Santa Rosa forest gardens.

Inmv value	Descriptive	State of weed vegetation in 10 x 10 m^2 subplot
1	heel high	less than 20 cm high
2	knee high	weed vegetation covering more than 50% between 20 cm and 50 cm.
3	waist high	between 0.5 and 1.5 m for more than 50% of the subplot
4	person high	between 1.5 to 2.5 m for more than 50% of the subplot
5	secondary forest	exceeds 2.5 m for more than 50% of the subplot

aged vegetation as a significant threat to a terra firme agricultural field with manioc, plantains, or tree vegetation.

I_{nmv} value 3 indicates a non-managed vegetation between 0.5 and 1.5 m in height covering more than 50% of the subplot. The weed vegetation is waist high. This vegetation is perceived by farmers as competing with the crop vegetation and it impedes access to the field for harvesting purposes. In most cases swiddens which have such weed vegetation are considered to require a weeding.

I_{nmv} value of 4 was given to a subplot when more than 50% of it was covered by non-managed vegetation between 1.5 to 2.5 m in height. The weed vegetation is person high. It means that the field had not been slash-weeded for a long time.

Non-managed vegetation which exceeded 2.5 m in height was given a I_{nmv} value of 5, indicating a fully developed secondary forest. The I_{nmv} values and their descriptions are summarized in table 2.1.

In the forest gardens in Yanallpa the management patterns were evaluated by revisiting the fields several times during the stay in the village and observing the general state of the non-managed vegetation.

Yield estimates could only be obtained in the terra firme fields and not in varzea fields. In addition to observing the state of the non-managed vegetation every three months, the harvestable yield for each 10x10 m^2 subplot for the next three-month period was estimated. The estimates were specific for different species. For instance, in the case of fruit trees, the number of fruits which could be expected to ripen the next three months were counted, or estimated if their numbers were to large. For these estimates the help of the local field assistant, Pedro Revilla was crucial. The yield estimates were repeated five times over a 15 months production period.

CHAPTER THREE

THE PEOPLE AND THE PLACES

INTRODUCTION

The word ribereño originates from the word *ribera*, river bank, and indicates the rural populations close to the larger rivers in the Peruvian Amazon. Historically the river banks of the large Amazonian river systems have been the most important areas of population settlement, since rivers provided transportation facilities and access to rich fishing grounds (Lathrap 1970; Denevan 1976; Roosevelt 1980). In contemporary Amazonia most of the population's economic activities and settlements are located in the floodplain of the major rivers (Denevan 1984). In the Peruvian Amazon 87% of the rural population lives on the margins of the great rivers (Aramburu 1984).

The emergence of the ribereños as a cultural group began with the invasions of the Amazon region by Europeans. Researchers divide the history of the Peruvian Amazon into several periods. (1) Acculturation began with the Jesuits' attempts to Christianize the native population (San Roman 1975; D'Ans 1982; Meyers 1988; Golob 1982). (2) After the Jesuits were expelled from all South American territories in 1767, the local people became the principal work force in the exploitation of different forest products from the area. (3) The period of the rubber boom had a substantial impact on the indigenous people of the Peruvian Amazon (San Roman 1975; Padoch 1986), and was of great influence on the formation of the ribereños as they are today (Chibnik 1991).

The inhabitants of both of the two research villages, Santa Rosa and Yanallpa, fit very well into Padoch's general definition of ribereños as mentioned in chapter one. However, they also have their own unique backgrounds and histories. Santa Rosa and Yanallpa represent two types of ribereño villages because of their location in two different environments, and because of their differences in social structure and history. Most of the houses of Santa Rosa are located close to each other in a small village center on a terra firme hillock, but with easy access to the varzea. Its history is very much related to the history of a *fundo*, or large agricultural estate, located within a short distance of the village (Padoch & de Jong 1989). Yanallpa is located in the varzea and its houses are stretched out in a row along the river. The village has a much longer history. Yanallpa developed when people started to exploit, rather independently, this floodplain site. Important aspects of resource management, including access to land, are characteristically different between the two villages because of their different locations.

Although ribereños from the Peruvian Amazon have experienced much cultural change throughout their history, they have continued to live in the varzea, and exploit similar habitats. Their knowledge and understanding of this environment is profound. It is this ecological knowledge that allowed ribereños to develop the many agricultural methods that will be described in chapter four. In the present chapter, the people whose resource management is the subject of discussion will be introduced, and their social organization and physical environment described.

A BRIEF HISTORY OF RIBEREÑOS

Only a short time after the Europeans entered the South American tropical lowlands, the Jesuits gained control of much of the upper Amazon region and became the major agents of early European influence on the local population. Their control of the upper Amazon protected the Indians from the unscrupulous exploitation which befell the Brazilian Indians (Parker 1981; Ross 1978). However, active cultural transference by the Jesuits and population decimation as a result of diseases disrupted much of the local social structures, especially of riverine groups. During this period of the occupation of the region, productive activities included forest extraction and agriculture for local consumption, and for export to Quito (San Roman 1975; Golob 1982; D'Ans 1982). The local population became accustomed to new commodities which could be obtained by participating in a regional market economy only.

After the Jesuit expulsion in 1767, many former inhabitants of the settlements, which had been created by the missionaries, became small farmers living in isolated homesteads or in small groups (San Roman 1975). Outsiders gained easier access to the many forest products found in the Amazon. The indigenous population became the primary extractor of these products. To a lesser extent they became agricultural laborers on fundos, the large agricultural estates which were established in the region in the mid 19th Century (Stocks 1981). They lived and worked under feudal conditions, dedicating part of their time to subsistence agriculture and to the extraction of forest products.

During the rubber boom, around the turn of the century, more remote Indians became the victims of slave-raiders and were forced to work as slaves in rubber extraction. Many of the enslaved natives died as a result of the extreme hardship of their working conditions (Hardenburg 1912; Weinstein 1983). The events of this period had a pronounced effect on demography and ethnicity in the Peruvian Amazon (Chibnik 1991). Many new immigrants traveled to the Amazon, and remained in the area after rubber extraction stopped (Padoch 1986; San Roman 1975). The co-existence of tribal and detribalized Indians and of immigrants from other South American countries, Europe and North America resulted in the complex background typical for the ribereño population (Padoch 1986). According to Chibnik (1991), the process of detribalization and formation of a self-identified non-Indian, non-settler ribereño group occurred mostly during and after the rubber boom, between about 1910 and 1950. Most agricultural activities in the Peruvian Amazon stopped when rubber extraction became more lucrative.

In the period following the collapse of the rubber market, many of the former participants in the exploitation of this product became farmers, living on *puestos*, or smaller agricultural estates, mostly on the river banks. Many people turned to subsistence agriculture, while commercial farming increased moderately (San Roman 1975). Large fundos changed to a mixture of activities including cash cropping, cattle ranching and extraction. The labor force which had tapped rubber on these estates stayed and participated in the new activities (San Roman 1975; Higbee 1945). The owners of large fundos had usufruct over extended areas of land (Higbee 1945) and settlers who lived on these areas had to pay tribute to the owner in goods or in labor (San Roman 1975). From 1930 to about 1960 several other forest products experienced minor booms for short periods (Padoch 1987). From about 1934 until 1945 barbasco (*Lonchocarpus nicou*) a shrub which yields natural biocides, was grown in large quantities in the region. The fall of its price caused one more economic crisis in the region and led to the collapse and abandonment of most of the larger fundos (Stocks 1981).

The last event which had a major impact on the ribereño population was the discovery of oil in the Peruvian Amazon in the early 1970s. This resulted in the migration from the rural areas of thousands of men who went to work for oil companies in remote areas of the region. After several years, the number of people needed by the oil companies dropped, and many became jobless. However, most of those who had come from rural areas had become accustomed to a new life style in the oil camps and stayed in Iquitos. The population of this city increased dramatically during this period (San Roman 1975). The urbanward migration of young people still continues, resulting in a stable or decreasing number of inhabitants of many ribereño villages (Hiraoka 1985b).

RIBEREÑO POLITICAL ORGANIZATION AND SETTLEMENT PATTERNS

In contemporary Peruvian Amazonia, the largest part of the rural population are ribereños living in isolated villages along the rivers (Aramburu 1984). These villages may have one or two neighboring communities which can only sometimes be reached on foot. Large markets usually can only be reached by boat and are often far away. Only ribereño villages located close to large towns or cities are connected to them by road. In the *Departamento* of Loreto the population density was only 1.4 per km^2 in 1981. The population growth in the previous decade had been 2.6% per year. The province of Requena, in which Santa Rosa and Yanallpa are located, had a population density of 1.0 persons per km^2 (Ferrando 1985). Although such low densities suggest that sufficient land is available for agriculture in the Peruvian Amazon, this is only partly true. Varzea land appropriate for agriculture covers a limited area, and farmers living in a floodplain village have to compete for agricultural sites. Farmers living in many terra firme villages need to go far to find unclaimed land and, each time, fields have to be made at increasing distances from their houses. Since harvested products have to be carried to the village, larger distances to fields are less desirable.

Ribereño communities have a certain formal autonomy over the village area. The boundaries of this area are defined by the regional representative of the Ministry of Agriculture, in coordination with the village authorities. Ribereño villages have two principal political authorities: the *teniente gobernador*, who represents the local government, and the *agente municipal* who represents the mayor of the municipality to which the villages belong. Their responsibilities are administrative and they are empowered to keep local order. Both authorities are elected by the villagers. At infrequent meetings, village matters are discussed. Newly arriving inhabitants have to request membership in the community and, after this is granted, an area of land is designated for use by the newcomers. Although only the regional representatives of the ministry of agriculture can formally grant land use rights, even within the village boundaries, this agency usually follows the advice of the village authorities. However, favoritism is not unusual and leads to conflicts.

Santa Rosa and Yanallpa each represent a different type of ribereño village, both common in the Peruvian Amazon. Many caserios like Santa Rosa were founded by a labor force which stayed behind when owners abandoned a fundo (Hiraoka 1985a; Chibnik 1990; San Roman 1975). Since many fundos collapsed in only a short period of time, many of these villages have only a short history. Furthermore, most fundos were located on terra firme and the villages which remained after the estates collapsed often continued to be located on the same site. Since the fields of farmers in this type of village may be located at considerable distances, they often have second houses in their fields and may spend longer periods there when much work needs to be done.

Yanallpa represents the second ribereño village type. After the rubber boom,

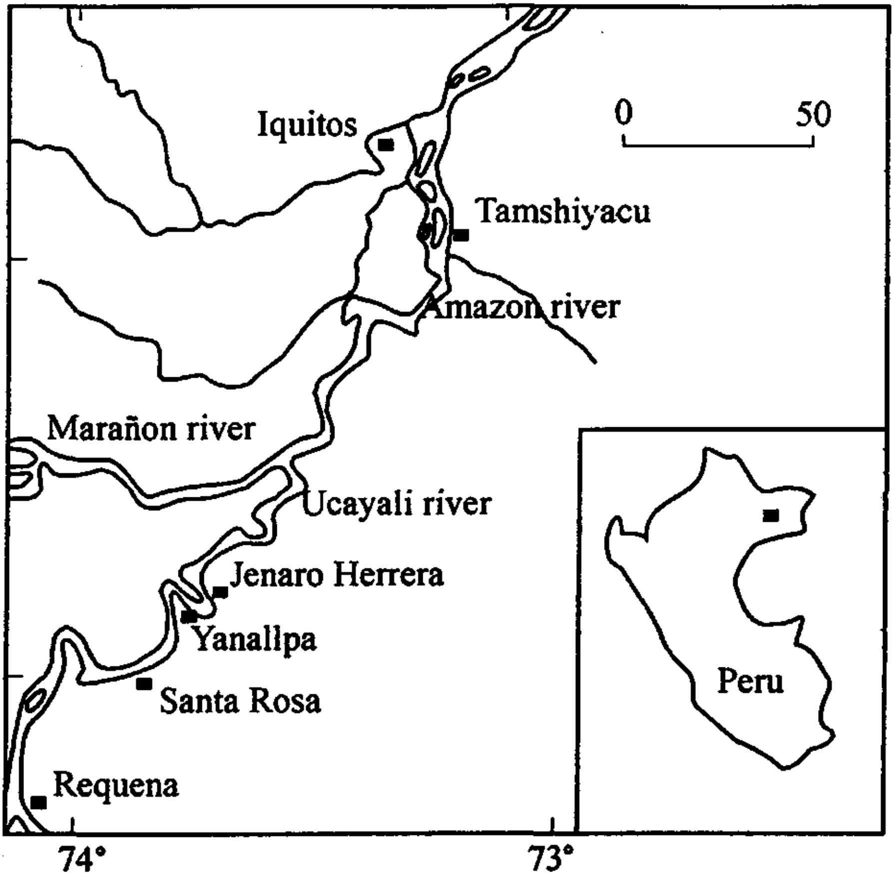

Figure 3.1 General overview of the research area and location the villages researched

many ribereños engaged in commercial and subsistence agriculture as well as extractive activities in isolated puestos, or smaller agricultural estates, located on levees. Often several of these puestos were located on the same higher levee, and in many places they finally merged into a single village. However, even when this happened, these villages maintained a structure of a long chain of evenly distributed farm houses along the river channel, each surrounded by fields. Farmers of varzea villages are less likely to own second houses than are farmers of terra firme villages, since agricultural fields are usually located near the house.

The only public transportation between the lower Ucayali region, and Iquitos is by *lanchas*, i.e. large passenger and cargo ships. Most farmers of this area deal with government agencies and banks, and sell and buy most of their products in Requena (Figure 3.1). Requena, a town of 10,000 inhabitants, contains government agencies and an agricultural bank. It is also an important regional market where farmers sell products. It has secondary schools and a hospital offering limited medical care. Several inhabitants of Santa Rosa and Yanallpa own a second house in this town and spend considerable time there, especially when their children attend secondary school. Farmers from the region have less frequent business interactions with Iquitos. Travel to Requena is mostly in small outboard equipped boats owned by farmers.

THE UCAYALI ENVIRONMENT

The two research villages, Santa Rosa and Yanallpa are located at 73°45'W - 4°55'S, on the true right side of the Ucayali river, about 150 km southwest and upriver from Iquitos and about 70 km above the confluence of the Ucayali and Marañon rivers (Figure 3.1). The landscape of the lower Ucayali consists of a large floodplain in front of the two villages, and a large terra firme area east of Santa Rosa (Figure 3.2 D). The floodplain area is shared by the Ucayali and Marañon rivers and extends to about 200 km upstream from the rivers' confluence (Dumont et al. 1990). It consists of levees, swamps, and many small and large lakes (Lopez & Freitas 1990). It is a part of the National Reserve Pacaya-Samiria and restrictions on the use of local resources exist. Hqwever, agriculture close to the river, harvesting of non-timber forest products, and non-commercial fishing are allowed (COREPASA 1986). The terra firme lands to which Santa Rosa farmers have access are Tertiary deposits, dissected by numerous small rivers, resulting in a hilly landscape typical of large areas of Amazonia (e.g. Denevan & Padoch 1987; Hiraoka 1986).

As explained in chapter one, the natural levees, or restingas, vary in soil characteristics and elevation and, therefore, have different agricultural potentials (Hiraoka 1985a,b). Mud bars (barreales), and beaches (playas) are soils which are yearly renewed. On barreales ribereños obtain the highest yields of rice, their most

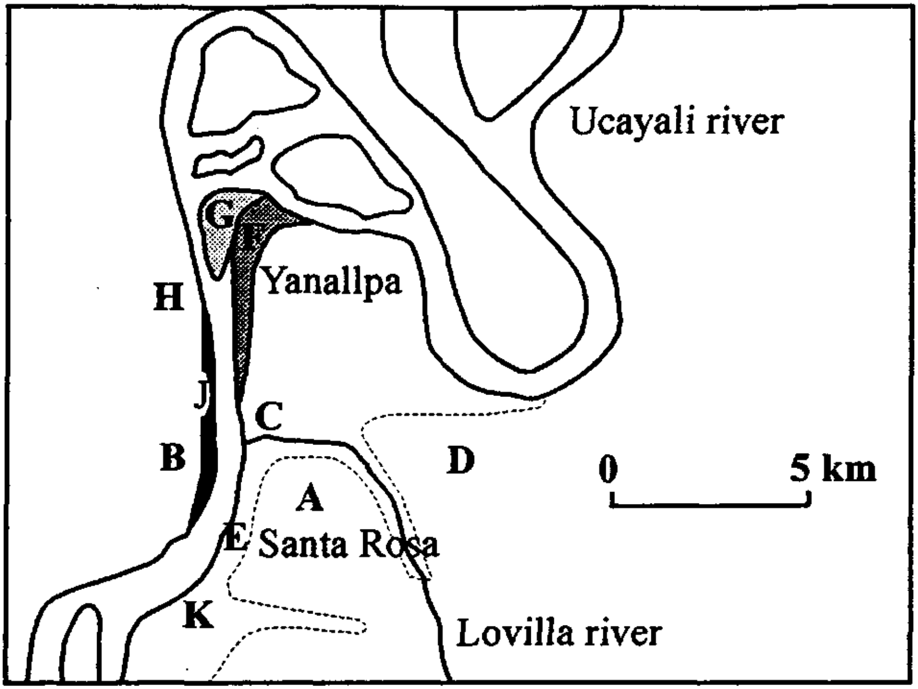

Figure 3.2 Map of the surroundings of the villages researched. Santa Rosa: A = location village and terra firme hillock, B = low levee across the river, C = low levee downstream from village, D terra firme across Lovilla river, E = *Mauritia flexuosa* swamp in front of village hillock, J and K locations of mud flats. Yanallpa: F = location village and principal high levee, G location of sand beach, H = location of lower levee across river.

important cash crop during the 1980s. Barreales are usually located adjacent to levees (Denevan 1984), but also lie in depressions between ridges (Lamotte 1990).

Mauritia flexuosa swamps, or aguajales, are a very common feature in large areas of Amazonia (ONERN 1977). Although their ecology is still being studied and conclusions remain provisional (e.g. Kahn & Mejia 1990), aguajales appear to be an early succession stage of varzeas which have been cut off from the river channel by natural levees and which were invaded by *Mauritia flexuosa* (Kahn pers. com.). Aguajales have standing water for most of the year and these conditions lead to organic matter accumulation (Gonzales Boscan 1987). As long as these palm forests contain standing water, they are not used for agriculture.

The flooding regime is one of the principal determinants of agriculture in the Ucayali floodplain. The fluctuation of the water level at the Jenaro Herrera research station is shown in Figure 3.3. The lowest river level is reached around September, after which the water starts rising. Its level rises very slowly, to reach its highest point around April or May. Once the water level starts to lower, it drops in less than two months to only a little above its lowest point. In about 25 to 30 days, however, most agricultural lands emerge (Hiraoka 1985b). This pattern of a gradual rise of the water level followed by a fast drop is an important feature of the flooding regime, and as such is well understood by farmers.

Although the changing of the water level of the Ucayali river shows a fairly regular pattern, minor differences between years are of extreme importance for varzea farming. Very small differences in the highest level can have profound consequences for how much land is flooded. In turn, this influences where and how much soil is deposited, and therefore what land use options exist after the flooding season. The flood of 1985, for instance, was very low. It was followed by a much higher flood in 1986. However, the difference between the highest level in 1985 and the highest level in 1986 was only 1.5 m. The 1985 flood barely covered the lower levees in the Ucayali floodplain and left many fields unsuitable for cropping. In 1986, even the highest parts of the river levees were inundated, leaving fields on both low and high levees clean and replenished with silt for the following season. The two floods differed also in periodicity. The 1986 flood

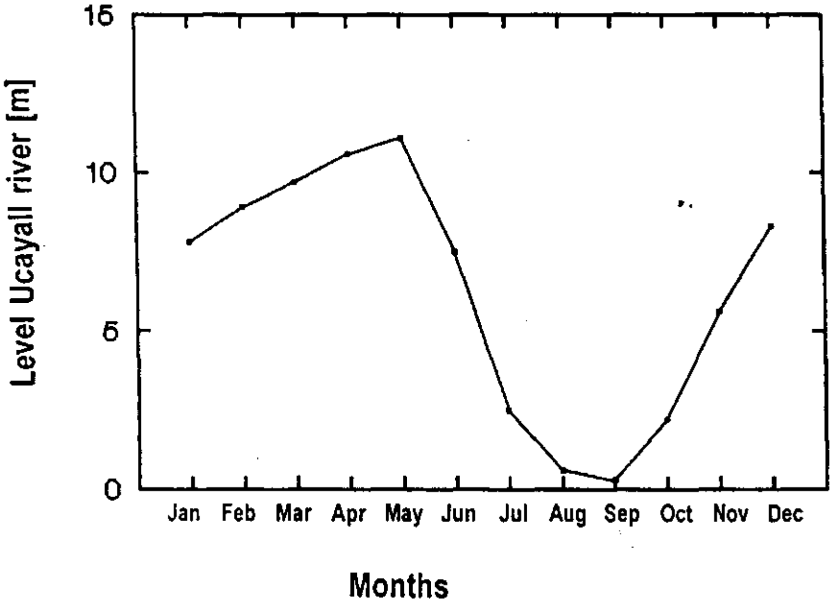

Figure 3.3 Monthly water level in the Ucayali river at Jenaro Herrera, 1985

reached its highest level much later than the one in 1985, leaving more than sufficient time for farmers to harvest all their lower varzea fields before the 1986 flood. On the other hand the late 1986 flood left insufficient time to harvest fields before the 1987 inundation and many of those growing rice on barreales lost part of their crops.

CLIMATE, SOILS, AND VEGETATION

The climate of the research area is typical of equatorial tropical rainforest regions. Data gathered from 1974 through 1983 at Jenaro Herrera show an average annual temperature of 26.5 degrees Celsius. Monthly averages range between 25.4 degrees in July and 27.1 degrees in December. The lowest monthly precipitation measured was 53.7 mm, and the highest 537.7 mm. The average annual rainfall is 2521 mm, while yearly averages varied between 1836 and 2800 mm in the 10 year period. Although there is no pronounced dry season in this part of the Amazon region, average rainfall is lower between June and September and between December and March than during the rest of the year.

Terra firme soils in the research area are classified by Sombroek (1984) as ferric Acrisols (Paleudults) or orthic Acrisols (Tropodults). These are well developed Ultisols with good to moderate drainage and medium to fine texture. They are acidic (PH 4.0 to 5.0), with a low to medium organic matter content. The base saturation varies from 35% to 40%, while aluminum saturation is 30% to 70%. In general, these soils are of low quality for agriculture, but are slightly better than many Oxisols found in Brazilian Amazonia.

In the floodplain, soils differ greatly in texture. Sandier soils occur on levees, while backswamps and mud bars display finer soils. Considerable micro-variation in soil texture may occur across single landforms (Denevan 1984). The higher levees are composed of Fluvisols (Fluvents) with sedimentary stratification and free internal drainage. The lower stretches, such as the backswamps, are predominantly Gleysols (Aquepts, Aquolls), with restricted internal drainage. The latter are non-acidic with high-activity clay mineral assemblages (illite/montmorillonite) (Sombroek 1984).

Natural terra firme and floodplain vegetation in the research area varies. In Santa Rosa, terra firme is largely covered by primary tropical rainforest. Researchers have offered classifications of these forests (Encarnacion 1985; Lopez & Freitas 1990; ONERN 1976), but cannot agree on forest types (Lopez & Freitas 1990). The vegetation of the varzea undergoes more impact by abiotic factors than does terra firme forest (Salo et al. 1986; Dumont et al. 1990). A newly initiated succession on recently deposited lands may be interrupted before a fully developed forest is reached. The vegetation on a particular floodplain site depends on its age, the floodwaters that inundate it, the texture of sediments, the sedimentation rate, and the periodicity of flooding (Junk 1984). Within short distances a mosaic of forest patches in different successional stages may be found (Lamotte 1990; Salo et al. 1986; Dumont et al. 1990; Encarnacion 1985). Periodic abiotic impacts result in forests whose flora is, on the average, less high, less diverse, and younger than those on terra firme (Denevan 1984).

SANTA ROSA: PEOPLE AND PLACE

Several of the people who founded Santa Rosa in 1960 had lived and worked on a fundo called Monte Carmelo. This fundo was founded around 1930 and was located on terra firme only a few miles upstream from today's location of Santa Rosa (Figure 3.1). Some of the detribalized Ashaninka Indians, who now live in the village, were brought to the region from the upper Ucayali to protect the fundo from raiding Mayoruna tribesmen. After the owner closed his estate, a group of laborers went with him to the Putumayo region, currently the border region between Peru and Colombia, to extract forest products. They traveled in the employ of the owner for probably about a decade, during which time they also were engaged in agricultural activities on the Amazon and Napo Rivers. Each place they settled, the group was joined by new people of different ethnic origin. In the early 1960s they finally returned to the Ucayali and settled at Santa Rosa, a small puesto on a high levee on the true right river bank slightly upstream from Yanallpa. The group included former members of several lowland societies, including Ashaninkas, Yaguas from the lower Amazon, and Quichuas from the upper Napo. All these people had abandoned tribal life and spoke Spanish with each other. Other people of Santa Rosa have Cocama, Cocamilla, and Conibo tribal backgrounds. The adventures of the people who founded Santa Rosa have been extensively discussed elsewhere (Padoch & de Jong 1990).

The natural levee where Santa Rosa was first located eroded away by the end of the 1960s (Figure 3.2, C). At that time, farmers started making fields on the terra firme peninsula on which the village is located today. However, most Santa Rosinos built their houses on the levee across the river (Figure 3.2, B) because they feared the Mayoruna Indians, who used the terra firme areas as their hunting grounds. The levee on the left river bank was slightly lower than the levee of the previous location of the village, and several high floods destroyed much of the farmers' crops. These losses finally encouraged the Santa Rosa people to move to terra firme lands in the early 1980s. After the village school was relocated to the peninsula hillock in 1981, most Santa Rosinos built houses there, establishing the village on its present site (Figure 3.2 A).

Santa Rosa is now located on the right bank of the Ucayali river. The hillock on which Santa Rosa is located, is part of a terra firme peninsula surrounded by periodically inundated lands. To the West, the peninsula is bordered by a *Mauritia flexuosa* swamp, or *aguajal*, which separates Santa Rosa from the river (Figure 3.2 E). To the South this swamp stretches inland and forms the southern limit of the peninsula, which also forms the border of the village area (3.2 K). To the North the aguajal changes into a lower levee area (Figure 3.2 C). A small watercourse called Lovilla and its floodplain separate the Santa Rosa peninsula at the northeast from the inland terra firme (3.2 D). The Lovilla joins these Ucayali river to the north of the village. The *Mauritia flexuosa* swamp, levee, and Lovilla floodplain all flood during the high water season.

On the small terra firme hillock, on which Santa Rosa is located, the houses are built in two rows on either side of a wide un-leveled lane. To reach the river the *Mauritia flexuosa* swamp has to be crossed by an unstable bridge. The village lane leads to the school with a small soccer field in front. Although most Santa Rosinos prefer to live in the village center, several houses are located alongside the boundary between terra firme and the *Mauritia flexuosa* swamp. A few Santa Rosa families still live completely within the periodically flooded varzea. In 1986 Santa Rosa had 326 inhabitants, belonging to 46 households.

Santa Rosa farmers use both varzea and terra firme sites for agriculture. The entire terra firme peninsula has been farmed. Today part of it is under swiddens, and part under swidden-fallow agroforestry fields. New fields are being opened up in the terra firme area across the Lovilla floodplain (Figure 3.2 D). The Lovilla floodplain itself cannot be used for agriculture since it tends to flood several times during the year after heavy rains. In the varzea the low levees north of the village (Figure 3.2 C), as well as those across the river (Figure 3.2 B), are used for agriculture. Barreales appear in front of levees across the river (Figure 3.2 J) and on the right bank of the river in front of the aguajal (Figure 3.2 E, K). Only a very small area of sandy playa appears in Santa Rosa each year, next to the principal barreal area (Figure 3.2 J).

Aerial photographs from 1957 and 1983 show how the Ucayali river has moved much closer to the Santa Rosa terra firme, eroding large parts of the original aguajal. The part that remains is being built up by river deposits whenever it floods, and can be used for agriculture during low water. The *Mauritia flexuosa* population, if not slashed, is dying, perhaps because of these deposits. Since the Santa Rosa farmers moved to terra firme, the aguajal area has been used principally for rice growing.

A HISTORY AND GEOGRAPHY OF YANALLPA

Yanallpa is much older than Santa Rosa. According to local informants, the first ribereño inhabitants of the levee on which the village is located (Figure 3.2 F) settled there around the turn of the century. Although some rubber tapping occurred close to the village, the few puestos, or smaller agricultural estates engaged merely in providing agricultural produce and firewood to boats and to the nearby river Tapiche area were rubber was heavily exploited. The village of Yanallpa was founded on the 12th of October 1911 as *Santa Cruz de Yanallpa* by a man named Francisco Lovera.

Much of the early history of the village is irretrievably lost. The people who lived longest in Yanallpa came there in the early 1940's. At that time the village consisted of 30 houses and about 220 inhabitants. It already had a central road alongside the river, a central plaza, a school, and village authorities. During this period farmers grew plantains, rice, and manioc in restinga fields. Some farmers had a few cattle. According to several informants, many farmers grew fruit trees including oranges, *Quararibea cordata*, and *Pouteria caimito*, species which are no longer found in the village as they do not tolerate flooding.

Many Yanallpa inhabitants apparently left the village around 1948 to live elsewhere on the terra firme because of repeated, extremely high floods. Farmers had sold their cattle. Fruit trees which could not tolerate waterlogging had died, and the village was almost abandoned. There were neither school nor village authorities anymore. After a few years of relatively low floods, however, new people again settled on the Yanallpa high levee.

The increased demand for natural rubber from Amazonia in the Second World War (Padoch 1987) resulted in some collection of rubber in the Yanallpa area. In the 1940's and 50's Yanallpa inhabitants went on long extraction expeditions to other regions, but later returned to the village. Since the early 1960's jute (probably *Corchorus capsularis*) became the principal cash crop, but after a few years it was replaced by *Urena lobata*. In the early 1970s the Peruvian agricultural bank started providing bank loans for corn and rice production and established controlled prices for these products. Since then many farmers in Yanallpa began to grown corn and rice as their principal cash crops.

A sketch map of Yanallpa drawn by a topographer in the Ministry of Agriculture in 1970 shows 44 different farms in the village. In 1986 only 14 of the owners of these farms or their spouses still lived in the village, but several of them had changed the location of their farm. In the last two decades the village has moved slightly upstream since the downstream part of the principal levee is now separated from the river by a newly built lower levee. The village still has its main road along the river and a village center with school and soccer field. The houses are stretched out along the main road, with only a few houses surrounding the central plaza. Some people who farm within Yanallpa boundaries live most of the year in the nearby town of Jenaro Herrera. In 1986 a total of 322 people lived permanently in Yanallpa in 50 households.

Yanallpa is located on a convex higher levee, which is part of a large river meander (Figure 3.2 F). Both houses and agricultural fields are found on this levee up to its upstream border, since the ground level remains fairly even. Towards the downstream border the level falls. There the levee is still used for agriculture, but not for permanent housing. The principal village levee is slowly eroding upstream, while downstream a new ridge is being deposited in front of an older one. The newly built levee becomes part of a large beach during low water, reaching upstream as far as the village center (Figure 3.2 G). The widest part of the principal levee (measured during low flood) is 360 m. The principal levee drops abruptly near the main river channel. On the back slope, however, the land descends slowly and ends in a forested swamp area.

Across the river from Yanallpa, a low levee stretches along the main river channel (Figure 3.2 H). The width of this levee varies; it is about 200 m at its widest point. Behind the levee, the mixed landscape of swamps, lakes, and low levees continues (Lopez & Freitas 1990). Except for the higher principal village levee, the entire area floods yearly. The higher levee is inundated only during extremely high floods, like the one in 1986. Agriculture is pursued on the main levee (Figure 3.2 F) and its backslopes, on the lower levee across the river (Figure 3.2 H), on the sandy beach (Figure 3.2 G), and on the mud bars that appear in front of the levees and in depressions on both sides of the river. During the 1986 flood the water stood between 1.5 and 2.5 m above the fields on Yanallpa levee on the true left river side (Figure 3.2 H). Soils in these lower restingas are of loamy texture, but less fine than those on the mud bars. The principal Yanallpa levee has soils of coarser texture on the top, but loamier soils on the backslopes. The highest parts of the principal Yanallpa levee were covered with about 0.5m of water in 1986.

CHAPTER FOUR

AGRICULTURAL DIVERSITY IN FLOODPLAIN FARMING

INTRODUCTION

Agricultural diversity (see page 28 for a definition) among a specified group of farmers, is the result of their use of diverse agricultural practices. Variations in agricultural strategies are possible in a single group of farmers because they use more than one agricultural practice. Hence, a discussion of agricultural diversity is necessary before the variation in agricultural strategies can be assessed, as the next chapter attempts.

Which are the most important characteristics of certain agricultural practices depends on the scale of comparison. For example, Duckham and Masefield (1969) used four degrees of land use intensity and land use types as the two main characteristics for a classification of agriculture on a world-wide scale. Turner and Brush (1987: 7) use the type of technology applied, in addition to land use intensity and production type, as a third distinctive characteristic to classify farming practices. The more specific a classification of agricultural practices becomes, the more characteristics can be included in distinguishing categories.

In the case of ribereño agriculture, the natural conditions of agricultural sites constitute one of the factors which determine agricultural practices. As explained in the previous chapter, and following the classification used by Hiraoka (1985a,b), ribereño farmers in the Peruvian Amazon use six different biotopes for agriculture. Since in each one of those site conditions are different, the latter is to be one of the characteristics which have to be used for a typology of ribereño agricultural diversity. Different sites are used to grow different crops, and each specific site-and-crop combination requires its own agricultural techniques. Furthermore, as a result of flood and climate seasonality, land use activities take place during different parts of the year in different sites. These characteristics co-define ribereño agricultural practices.

An organizational concept, called *agricultural type*, is used here to describe the different ribereño agricultural practices. An agricultural type is defined as: a unique site-crop (or crop mixture) combination, which requires a specific set of agricultural techniques, and a specific calendar of activities. Each agricultural type, furthermore, has a certain average production level, a principal destination of output, and the type and level of risk. In this chapter the agricultural diversity among ribereño farmers of Santa Rosa and Yanallpa is discussed by describing fourteen agricultural types which were observed in those two villages. Previously it will be explained why the concept of agricultural type is an appropriate tool to illustrate diversity of ribereño agriculture.

AGRICULTURAL TYPES, A CONCEPT FOR LAND USE CLASSIFICATION

The agricultural type concept is most similar to the cropping system concept used by several authors (e.g. Fresco 1986; Conway 1985; Shaner et al. 1982). According to Fresco (1986: 110), a cropping system is "a land use unit that transforms plant material and soil nutrients into useful biomass". Besides several physical components, a cropping system has inputs of management and labor. It is interesting to note that Fresco distinguishes *field types* to account for the variation between agricultural fields belonging to the same cropping system. Field types are defined as "the location of specific combination of cropping systems components in a given agro-ecological and socioeconomic environment" (Ibidem).

Although an agricultural type, as defined above, includes a specific combination of the components which Fresco uses to distinguish cropping systems, the two concepts are not identical. The word *site*, in the definition of an agricultural type, includes a specific agro-ecological environment, corresponding to *biotope* as used by Denevan (1984) and Hiraoka (1985a,b) in their characterization of varzea resource use. However, specific labor requirements and scheduling, type and level of risk and uncertainty, specific agricultural techniques used, and output levels, are factors which are also characteristic for a specific agricultural type. These characteristics may vary in fields within one single biotope, and they, in particular, differentiate the agricultural type concept from the cropping system concept. The definition of an agricultural type is closer to Fresco's definition of a field type than to the cropping system.

An important justification for a classification in terms of agricultural types is its intrinsic combination of ecological, technical, and economic features. Since each agricultural type described below has its own requirements as to amount and calendar of labor input, risk, and yield levels, the choice of a certain agricultural type reflects an option for a specific allocation of those limited productive resources. This means that a choice for one agricultural type reflects partly a farmers agricultural strategy. Hence the agricultural type concept is also appropriate to evaluate agricultural strategies.

The distinction of particular agricultural types in the present study is based on a classification of agricultural fields in Santa Rosa and Yanallpa. The categories were derived from surveys of numerous fields. They are consistent with a classification which farmers themselves apply in the two villages. The assessment of the economic characteristics of agricultural types was obtained through participant observation, interviews with many farmers, and notes from daily work diaries kept by a few farmers. The names of most agricultural types combine the name of the land form on which it is found, and the principal crop or crop combination that is grown.

It was attempted to specify as much as possible a single set of characteristics to describe each of the fourteen agricultural types discussed below. These characteristics are: (1) site conditions, (2) crops grown, (3) techniques used, (4) calendar of cultivation activities, (5) estimates for labor inputs, (6) production levels, (7) destination of the output, and (8) type and level of risk involved. However, the precision of the presented information can not be the same for every agricultural type. Some agricultural types were found among only a few farmers. As a consequence less information could be obtained about these types. In the following discussion, the estimates for labor input and production levels all refer to a field equivalent of one hectare.

Of the fourteen agricultural types discussed below, ten are located in the floodplain and four on terra fire lands. The floodplain agricultural types included six located on several parts of the restingas: restinga rice fields, restinga chacra, restinga plantain fields, restinga forest gardens, restinga corn fields, restinga vegetable fields, and restinga jute fields. The barreal rice fields were located on the barreales, playa cowpea fields on the playa, and aguajal rice fields in the Santa Rosa aguajal area.

Four terra firme agricultural types were distinguished among Santa Rosa farmers: terra firme rice fields, terra firme chacra, terra firme plantain fields, and the terra firme forest gardens. Some remarks concerning the relation between terra firme agricultural types is necessary. The variation in soil conditions of the Santa Rosa terra firme landscape is mainly a result of its dissected topography. In the typical hilly landscape, soil fertility and moisture increase from the top to the bottom of slopes, while soil drainage is better on the higher parts. Amazonian farmers often adjust their planting of crops to such gradients in their fields (Denevan 1984). In Santa Rosa these gradients occur mostly over a distance of less than 100m. However, the variation in agricultural potential of different terra firme fields is principally influenced by the land use history of the site and not by variation in soil quality.

A terra firme rice field, terra firme chacra, and terra firme plantain field all can be started as a field newly slashed in primary forest vegetation. However, both the chacra and the plantain fields may also follow as a second agricultural type after the field has been used first as a terra firme rice field. It is most common, however, for a chacra to be started as a new swidden, while a plantain field normally succeeds to a terra firme rice field. Only the forest garden is an agricultural type that always follows a chacra or a plantain field.

RICE AGRICULTURAL TYPES

Barreal rice fields

Ribereño farmers only use dry rice cultivation. Irrigated rice farming in the floodplain would be severely limited by river floods, even with a frequency of once every several years. The rice cultivars which ribereños plant are short cyclic varieties. They are short grain rice varieties of *Oriza sativa* ssp *japonica* (Purseglove 1975; Williams 1975; Gupta & O'Toole 1986). In Santa Rosa and Yanallpa farmers grow rice in four ecologically different zones.

Figure 4.1: General calendar of some agricultural types with marked seasonality: C=preparation; P=planting; W=weeding; H=harvesting

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
barreal rice						PP		W		HHHHH	CC	
restinga rice	WW	HH	CC					CCCC		PP		
aguajal rice		CC	PP				WWWWWWWW		HHHHH			
terra firme rice				HHHHH					CCCC			PPP
restinga chacra		H H H H HHH			CCPP	WW						WW
restinga corn			CHCHCH			CPCP	WW			CHCHCPP		WW
playa cowpea							PP			HH		

The principal limitation for agricultural production on barreales is their short flood-free period. In Santa Rosa and Yanallpa, barreales start to appear as flood water recedes, somewhere in June, and become flooded again towards the end of October or early November (Figure 4.1). In most years this period is just long enough to grow one crop of the rice varieties planted by ribereño farmers. However, only a slight difference in the flooding regime may shorten the flood-free period and hence may lead to losses of a considerable part of the rice crop. Rice production on barreales in the region was reported as early as 1943 (Higbee 1945), but Santa Rosa and Yanallpa farmers have used barreales for rice production only

Table 4.1: General features of the agricultural types described in this chapter

Agricultural type	Landform	Yield/ha/yr	Purpose	Risks
barreal rice	barreal	1,500 kg	sold	flooding field, labor shortage for harvesting, high labor need when circumstances unfavourable
restinga rice	low restinga	1,100 kg	sold	low yield
aguajal rice	aguajal	2,500 kg	sold	high labor need for weeding
terra firme rice	terra firme	750 kg	sold	low yield
restinga chacra	high restinga	10,000 kg (manioc)	consumed	flooding field, high labor need for weeding
terra firme chacra	terra firme	10,000 kg (manioc)	consumed	household, bad burning new field
restinga plantain	high restinga	500 racemes	sold/consumed	flooding field, low price plantains when sold
terra firme plantain	terra firme	200-400 racemes	sold/consumed	bad burn debris, low price plantains when sold
restinga agroforestry	restinga		consumed	loss of crops due to flooding
terra firme agroforestry	terra firme		consumed	
restinga corn	low restinga	1,300 kg	sold	low yield
playa cowpea	playa	700 kg	consumed/sold	low price cowpea
restinga jute	low restinga	5,000 kg	sold	high labor need for weeding
restinga vegetables	high & mediumrestinga		sold/consumed	pests, diseases

since the early 1970s. Without bank loans and controlled prices, rice was never a favored cash crop in barreales. However, during the present study barreal rice production was one of the most important cash crop activities among ribereños (Chibnik 1990; Pinedo 1986).

Barreales usually emerge as clean deposits of heavy silty material on which the rice can directly be broadcast (Table 4.2). Soils, however, must be wet to make this planting method successful. Once barreales start emerging, farmers plant the newly appearing parts at least every other day. As soon as the soil dries, broadcasting will not be successful anymore. Broadcasting is continued until the newly exposed soil reaches a level which is estimated to stay flood free long enough to allow harvesting of the rice. The land lying below this level is not expected to remain out of the water long enough for the rice crop to mature, and therefore is not planted. A barreal rice crop which is flooded, even if it does not totally submerge, does not produce a good yield. Local farmers hold that the sediment of the river water that sticks to the rice plants damages the crop. The heavy silt load of the Ucayali river probably inhibits the production of flooded rice as it is reported in floodplains in other parts of the world (Hanks 1972; De Datta 1981; Ten Have 1982).

Barreales are excellent soils for rice production because of their high soil fertility, and good water retention capacity (Roosevelt 1980; Purseglove 1975). The latter characteristic is especially important since water supply is the chief limiting factor in upland rice cultivation (Purseglove 1975; Gupta & O'Toole 1986; De Datta 1981). Under ideal situations, barreales yield up to 4000 kg/ha of unhusked rice (Laur undated; Chibnik 1990). However, an average was recorded of only some 1,500 kg/ha among all the farmers in Santa Rosa (Table 4.1). This low average is a consequence of farmers growing rice in sites were the river deposited sediment which is to sandy, or the mud layer was too shallow. Although the average of barreal rice production is much lower than the potential maximum yield, it still compares favorably with production levels of small farmers in many other parts of the world (e.g. Williams 1975).

A barreal usually is only slowly invaded by weeds, since the newly deposited mud contains few or no seeds. After the rice harvest, just before the flood, the area expected to receive mud deposits during the next flood is completely slash-weeded. The labor invested in field preparation and weeding in a barreal is much lower than in any of the other sites used for rice production. Broadcasting requires only about five workdays/ha (Table 4.2). As little as five workdays may also be spent on weeding, while the amount of labor used for harvesting depends on the yield level. Since a single worker harvests an average of 80 to 100 kg/day, a yield of 1.5 metric tons would require no more than about 20 days of work. A considerable amount of labor is spent on post harvest treatment (Laur undated). The labor spent on slash-weeding a barreal before the flood varies between 20 and 30 workdays/ha. Broadcasting, weeding and harvesting add up to 60 workdays/ha. Hanks (1972) reports an average of 42 workdays/ha for broadcasting systems. In the systems he describes, however, land preparation is done by plowing, while average yields are 1.3 tons/ha.

Although barreales are the most favored sites for cash cropping, farming these sites involves several constraints and risks (Table 4.1). When ripe, the rice has to be harvested within a period of only a few weeks to avoid losses due to flooding. Moreover, the crop may become over-ripe and in that case much rice will be lost during harvesting. In addition to hiring labor, farmers must invest money, for

Table 4.2: Comparison of four rice agricultural types

Agricultural Type	Use Frequency	Planting Technique	Labor expenditure (day/ha) Preparat.	Planting	Weeding
barreal rice	yearly	broadcasting	25	5	5
restinga rice	first year	dibbling	40	25	10
aguajal rice	yearly	broadcasting	50	5	25
terra firme rice	first year	dibbling	50	25	5

instance, for transportation of the product (Chibnik 1990; Laur undated). Sizes of barreal rice fields farmed by single farming units range between a quarter of a hectare and ten hectares. During the field work farmers relied on bank loans to hire non-family labor to harvest their barreal rice. The difficulties and risks of using bank loans have been discussed in more detail by Chibnik (1990).

Several other risks threaten barreal rice growing. The greatest is crop loss to an early flood. Such losses occurred, for instance, in 1986 when some farmers lost as much as half of their crop. Sometimes large amounts of seeds of obnoxious weeds may wash into the field, increasing weeding labor requirements. Floating meadows, mainly consisting of *Paspalum repens* and *Echinochloa polystacha* (Junk 1970) may be stranded on fields still flooded. If this occurs, these floats are dragged into the river again. Certain parts of an area expected to yield barreales may have been cleared before the flood, but then left without sufficient mud deposits once the water drops. This means that the labor invested is wasted. The soil deposited by the river may turn out to be to sandy, or barreales may disappear altogether as a result of river erosion.

Restinga rice fields

On restinga sites, rice is mostly grown as a first crop in a field cleared for the first time in the forest (Table 4.2). In older restinga fields the risk of heavy weed invasion is high. Growing rice in an older restinga field is not very common. In newly slashed fields either fewer seeds of unwanted weeds are present, or most of them are killed by burning the debris. Sometimes farmers abandon a restinga rice field because of excessive weed competition. Within close range of the two villages studied, only restinga areas at relatively low elevations still have high forest, where the underlying soil is appropriate for rice growing. After a flood, the forest soil is left to dry before a new field can be slashed. New restinga fields, therefore, are not made earlier than August (Figure 4.1, see also Hiraoka 1985b). Once the forest is slashed, the debris must dry for about one month before it can be burned. Before planting, most of the unburned smaller stems and branches are gathered into piles where they are burned again.

Rice is planted in a restinga field using the dibbling technique (Table 4.2). About two months after planting the seeds, a minor weeding is done. Children often stay in the fields to scare away birds which come to feed on the rice when the crop is ripening. Harvesting usually starts four months after the rice has been planted. Farmers reported an average yield of 1,100 kg/ha, which is much lower than the 2.0 to 2.5 metric tons Hiraoka (1985b) reported. The highest yield reported by a farmer in Santa Rosa was 3 metric tons/ha. Only shortly before the field is flooded, a complete slash-weeding is carried out to prepare the land for the next year's use. Farmers are much less willing to hire laborers to work in restinga than in barreal rice fields because of the lower economic return per unit of labor in a restinga rice field.

The labor required to produce a rice crop in a restinga field is higher than in a barreal field (Table 4.2). An investment of 40 workdays to slash and burn the field was recorded, which is lower, for instance, than the 53 to 56 workdays reported by Gupta & O'Toole (1986) from Sierra Leone. A total of 25 workdays are required for planting, while close to 10 days are spent on weeding. The labor spent on harvesting depends again on the amount of rice harvested, but because of more difficult conditions in a restinga field a worker can harvest less in a single day than in a barreal rice field. An average production of 1,100 kg/ha requires 15 to 20 days of harvesting. Thus a restinga rice field needs a total of 90-95 workdays for producing one crop only.

The main risk in growing rice in a restinga field is that production will be low and with it the economic return of the labor invested (Table 4.1). A low yield may be due to low soil fertility, but more likely to insufficient moisture during the growing cycle. Restinga soils are sandier than soils in barreales (Hiraoka 1985a), and have a much lower water retention capacity. A rice crop requires a minimum of 750 to 800 mm of rainfall during the growing season (Ten Have 1982; Purseglove 1975). Since a rice crop is especially sensitive to environmental stress during the reproductive phase (Williams 1975), short periods of dry spell, which are common in the Amazon region, also may cause significant yield losses (Gupta and O'Toole 1986).

Aguajal rice fields

Growing rice in the aguajal area, immediately West in front of Santa Rosa, differs in several aspects from the two other floodplain rice agricultural types described so far. A new aguajal field is prepared and planted in September or October, following a schedule similar to a restinga rice field. An aguajal field, however, can be used to grow rice for several consecutive years, probably because of the high organic content and moisture of the subsoil (Gonzales Boscan 1987). Weeds are the principal threat to the rice crop. An aguajal field therefore can only be used in a given season if during the previous flood sufficient sediment was deposited to inhibit excessive weed growth.

Shortly before an aguajal field is flooded, it is completely slash-weeded. Santa Rosa farmers have used the aguajal area in front of their village only since 1984. Since then, the main river channel has moved closer to the aguajal, and each year a larger part of it is flooded with sediment-rich water. The increased use since 1986 is a consequence of deposition of sediments in a larger area of this landform. According to farmers, both the flood and sediment deposits reduce weed invasion. There are no alternative crops suitable for the aguajal. If rice cannot be planted, the labor spent on pre-flood slash-weeding is wasted. In 1985, for instance, only seven Santa Rosa farmers had planted their aguajal field because the previous flood had been too low.

In existing aguajal fields, rice is broadcast immediately after the submerged land reappears out of the water. Existing aguajal fields emerge shortly before the barreales, and thus broadcasting and harvesting are done a little earlier. Weeding starts about one month after the field is planted, and is continued until the rice is ripe. The harvesting periods of barreal and aguajal rice fields may overlap. This increases pressure on the labor supply if a farming unit manages a barreal and aguajal rice field at the same time (Figure 4.1).

The production of an aguajal rice field averaged 2,500 kg/ha, which is very high compared to many other upland small agriculturists rice cultivation systems (Williams 1975; Hanks 1972; Gupta & O'Toole 1986). This estimate, however, is based on data of only five fields. Labor requirements for planting and pre-flood slash-weeding are about the same as for a barreal rice field. The amount of labor spent on weeding is 25 to 30 workdays, but may increase under unfavorable conditions (Table 4.2).

The principal risk in farming aguajal rice fields is an excessive growth of weeds, which may result either in large labor requirements for weeding, or in crop losses when parts of fields are abandoned (Table 4.1). Labor spent on a pre-flood slash-weeding has a higher risk of being wasted than in a barreal or restinga field. However, there is very little risk of losing a crop to an early flood.

Terra firme rice fields

Terra firme soils are much less suited for growing rice than are barreales, restinga, or aguajal soils. Although soil fertility is adequate after burning of slashed vegetation (Sanchez 1973), the lack of sufficient rainfall during the four month cropping cycle accounts for the low rice production. Farmers in other parts of the Peruvian Amazon, who have no access to varzea grounds, commonly grow rice in this environment (Hiraoka 1989b). During the period of research only a few Santa Rosa farmers produced rice in terra firme.

Once a new terra firme field is slashed, felled, and burned, the rice is planted using the dibbling technique (Table 4.2). If the field is made in primary forest, no weeding is required before the harvest. A terra firme rice field made in secondary forest requires some weeding. Soon after the rice planting is finished plantains may be planted. In such a case the field is continued as a terra firme plantain field once the rice is harvested. Terra firme rice fields also may be replanted with manioc, or plantains after harvesting.

Terra firme rice is usually grown from December to April (Figure 4.1). During this period of the year rainfall is highest. Not only is this period most appropriate because of the higher rainfall in February and March, it also allows farmers to finish harvesting the upland rice before the varzea lands emerge. The new terra firme field has to be slashed around September or October, and burned just after the short dry period in December or January. The yield of eight terra firme rice fields averaged 763 kg/ha, which is much less than any other rice agricultural type. Labor investments for weeding are low. Harvesting requires between 15 and 20 workdays. The principal risks involved in growing a terra firme rice field are a poor burn of the forest debris, but more important, low production as a result of unfavorable growing conditions (Table 4.1).

CHACRA AGRICULTURAL TYPES

Restinga chacras

The word *chacra* is often used among local farmers to indicate any agricultural field in general, but refers mostly to a multi-crop field in which manioc predominates. The word is used here exclusively to indicate fields of the latter type. Restinga chacras and restinga plantain fields are both located on restinga sites with only higher elevation. Since plantains are extremely susceptible to waterlogging and do not produce in less than one year (Williams 1975; Purseglove 1975), the very highest parts of restingas are usually used for plantain fields. Restinga chacras are more often located on slightly lower sites. Restinga sites used for chacras are composed of the same sandy material as plantain sites, but in contrast to the latter, they are flooded during most years. This means that only crops which can be planted and harvested within a time span of about eight to ten months can be grown in a restinga chacra. There are fewer cultivated species in restinga chacras than in chacras on terra firme (see Hiraoka 1985b).

The restinga chacra provides manioc, which like plantains constitute the principal staple crop among ribereños (Table 4.1). In Santa Rosa and Yanallpa only varieties of sweet manioc are grown, which have no toxic levels of prussic acid in the edible part of the tubers (Purseglove 1974; Cobley 1976). Most of the yield of a restinga chacra is destined for household consumption. When the manioc of a restinga chacra is harvested there is an excessive supply in local markets and prices are low, so little of it is sold. A significant part of the manioc produced is used to make manioc beer, which is an important food in the labor exchange customs among ribereños (Chibnik & de Jong 1989). The annual river cycle forces farmers to harvest all the restinga manioc by the end of the season, since the crop does not tolerate waterlogging (Purseglove 1974), and starchy roots rot within a few days after flooding. The manioc, which is harvested in large quantities before the flood, is most commonly processed into *fariña* or baked manioc flour, since the tubers cannot be preserved for a long time (Purseglove 1974). Fariña is an important daily staple during the high water season in villages located entirely in the floodplain. It can be conserved and sold more easily than manioc, and most farmers sell some of it in Requena or in the village itself.

Restinga chacras are usually made in fields that have already been used previously. The sandy and well drained soil, which appears after the flood and which will be used as a chacra, needs to dry out for a shorter period than the lower restinga fields destined to grow corn. If the site to be used as a chacra was slash-weeded before the flood, then very little weeding has to be done before planting. Manioc is then planted using stem cuttings, and one month later the second weeding is carried out. The field is weeded a third time just before or during the harvest. Although manioc can be grown for as much as 10 months in a restinga chacra, certain varieties already may be harvested after only four months. Only short cyclic cultivars of manioc are planted in restinga fields. According to Hiraoka (1985b) production of manioc in floodplain fields ranges from six to 13 metric tons per ha. Although this is lower than the averages given by Williams (1975) for Brazil, it is not much lower than production levels of terra firme fields in Santa Rosa.

To cultivate a restinga chacra only family labor is used. Planting a manioc field requires about 10 workdays, while 25 workdays are needed for harvesting. The three weedings require an estimated total of 50 to 70 labor days. The upcoming flood may force farmers to harvest all the manioc early and convert it into fariña, or to store it in underground pits wrapped in *Calathea sp.* leaves. In the latter case, the manioc must be made into fariña after the flood. A restinga manioc crop has fairly constant yield, if it is planted early and can be completely harvested. However, sudden flooding of the field may result in losses if farmers are not prepared for it, or are absent from the village at the time. Planting stock may be lost during the flooding period, and then must be replaced from elsewhere. Weed invasion may result in more labor than expected, and a sudden need to harvest all the manioc may interfere with other urgent activities, such as harvesting rice or corn in restinga fields.

Terra firme chacras

The Santa Rosa terra firme chacra is similar to the typical upland agricultural fields described for many Amazonian farmers (e.g. Denevan 1971; Gasché 1980; Guyot 1975; Eden & Andrade 1987; Eden 1980; Harris 1980; Ruddle 1974). Although the species composition may be different from field to field, a chacra is always planted with manioc as the most important crop, and often but not always with plantains, as an important second crop. If Santa Rosa farmers grow manioc and plantain on a field, the plantain usually is planted first, and the manioc second. This sequence is different, for instance, among Tamshiyacu farmers near Iquitos, or Bora farmers who first plant manioc and then plantains (de Jong 1985; Padoch et al. 1985; Denevan & Padoch 1987). If the two crops are mixed, manioc is planted in the whole field, while plantains are planted only in certain parts. Other very common chacra crops are pineapple and sugarcane, which are also planted in certain areas of the field. Several studies on Amazonian swiddeners report the large number of crops which can be found in similar upland agricultural fields (Denevan & Padoch 1987; Hiraoka 1986).

The best period to slash and fell the forest vegetation for a new terra firme field is between June and December, since, in that period, rainfall is less than during the rest of the year. However, the demand of agricultural activities on the farming unit labor pool is lowest during the high flood season, so sometimes Santa Rosa farmers make their fields in the first half of the year. In the latter case they accept the increased risk that the debris will dry less thoroughly, resulting in a poor burn and lower field quality. A farmer usually will plant manioc and plantains as quickly as possible, but may continue to plant other crops over more than one year. The weeding pattern in terra firme fields which were made in primary forest is slightly different from fields which were made in secondary forest. Primary forest fields are weeded for the first time four to six months after the burning of the forest debris. The second weeding is combined with harvesting of the manioc. In secondary forest fields the first weeding begins one month after burning. The slashing and felling of the forest vegetation and planting need to be finished as soon as possible once they are started. Most other management activities of terra firme chacras, however, are scheduled in-between more urgent activities.

The terra firme chacra is a variable agricultural type. Crop combinations vary among fields, and change during a fields cycle. Furthermore, soil fertility changes during the life time of the field (Nye & Greenland 1960; 1964; Jordan 1981; 1989; Sanchez 1973), and weeding patterns vary according to the fields land use history. A terra firme field is managed as a chacra for one to four years. Sometimes only one manioc crop may be harvested, before the field is converted to a forest garden. Complete fallowing of a terra firme chacra is unusual. Farmers more commonly plant a second manioc crop after the first one, or plantains may be replanted and harvested over a longer period. The weeding pattern of a terra firme chacra changes as the production level of manioc and plantain drops, or when weed competition becomes too severe.

Between 26 and 59 workdays/ha were recorded for the slashing of primary forest, and 25 for secondary forest. Planting of a single manioc crop requires about 10 workdays, and weeding and harvesting some 40 to 50 workdays. The second manioc crop requires at least 80 workdays in total, since much more time is spent on weeding. In a terra firme chacra additional labor is spent on planting and harvesting of other crops. Production levels of terra firme chacras are difficult to measure since they are so variable, and fields are gradually harvested. Experiments in the nearby Jenaro Herrera research station resulted in production levels of manioc between nine and 20 tons/ha. Variation in production levels, more than anything else, is the result of differences in the care the field receives. The bulk of the yield of a terra firme chacra is destined for household consumption (Table 4.1). Sometimes, however, farmers may sell considerable amounts of manioc or plantains when prices are high, for instance a few months after a high flood period.

Chibnik (1990) has pointed out that ribereños attempt to assure themselves of a steady food supply from their fields, even if they take higher risks in their cash cropping activities. The risk involved in growing a terra firme chacra is very low. Pests and diseases are of minor importance in Santa Rosa chacras (Lourde pers.com. 1986). The most important risk is a period of unfavorable weather following the clearing of a field, resulting in a poor burn, and therefore lower soil fertility.

PLANTAIN AGRICULTURAL TYPES

Restinga plantain fields

Plantains and bananas (both cultivars of *Musa paradisiaca*) are important cash crops as well as food crops among ribereños. Plantains require well drained soils, but at the same time demand a sufficient water supply (Purseglove 1975). In the Peruvian Amazon this crop is grown both in the floodplain and on terra firme. The better soils for plantains are located in the floodplain. In the village survey, plantains were the third most important cash crop in Yanallpa. Although all *Musa paradisiaca* cultivars are in fact annual crops, perennation occurs as a result of vegetative reproduction through shoot forming (Williams 1975). Plantations of this crop therefore may reach advanced ages (Purseglove 1975). A plantain field on a high restinga can continue to produce for a period of at least 15 years without any need of fallowing. After this period the production decreases, probably as a result of nutrient deficiency. The fallow period of a previous plantain field need not be longer than two or three years. If a plantain field is flooded, the crop is almost completely destroyed. In such a situation, the field is often first used for a different agricultural type, before being replanted to plantain. Even if plantain fields are not flooded, a high subsoil water level does affect a plantain crop during high floods, often resulting in toppling of the plants.

Plantain fields only have to be replanted when a crop is destroyed by flooding, or after more than fifteen years of continuous plantain production. Shoots are planted on a grid pattern of about 4m by 4m. This is a lower density than on terra firme, where plantains are planted on a grid of about 3m by 3m. Although plantains can be planted at higher densities in the more fertile floodplain soils

(Purseglove 1975; Williams 1975), ribereños recognize that in later stages of the fields, through the crop's vegetative reproduction, these higher densities will be reached anyway. A mature plantain field needs only one or two slash-weedings per year. The shade of the dense plantain crop considerably reduces the growth of weeds (Williams 1975; Purseglove 1975). Most farmers schedule these slash-weedings during the end of the high water season when there are few other urgent tasks. Plantains are harvested whenever the racemes are mature.

Only little data was collected on yields of plantain fields. Hiraoka's (1985b) estimate of 200 racemes per year, however, appears lower than estimates from Yanallpa. One plantain agroforestry field that was surveyed had 533 plantain clusters per ha, many of which had full-grown new shoots. A mature restinga plantain field may have well over 1000 adult plants, and, in that case, a yield of 500 racemes per year is a conservative estimate (Table 4.1).

The labor requirements of a restinga plantain field begin with 30 workdays for planting a field. During the first year of a field's existence about 50 workdays have to be spent on weeding. A mature plantain field, however, only requires between 20 and 30 workdays for one or two slash-weedings. A total of 19 workdays/ha were recorded for a slash-weeding of a two year old terra firme plantain field.

The first harvest of a new plantain field, about one year after planting, is concentrated within a few months. In subsequent years the spacing of harvesting becomes irregular (Purseglove 1975; Williams 1975), and after a few years a field produces during the whole year. Risks of plantain growing are low cash returns because of low market prices for plantain, and total crop loss when a field floods. At the time of field research, infection of *Fusarium oxisporum*, which was already common in the vicinity of Manaus and Iquitos at that time, did not occur in plantain in Yanallpa and Santa Rosa.

Terra firme plantain fields

In a terra firme plantain field, besides the preparation and planting, the only activities required is one slash-weeding per year and harvest of the produce. As in restinga fields, terra firme plantain fields start yielding racemes about one year after planting, but, because of the composition of plantain and banana cultivars which have different maturing periods in older fields, racemes are harvested the year round (Purseglove 1975; Hiraoka 1989b).

A recently slashed terra firme forest area is sufficiently fertile for a good first year plantain crop. The rainfall regime of the region assures a minimum precipitation of 50 mm per month required for plantain on the well drained terra firme soils (Williams 1975). However, plantain fields in terra firme are only harvested for about four years, after which the production declines. It is not clear whether the decline in yield is a result of decreased soil fertility or excessive weed growth (Purseglove 1975).

The total labor input required for a terra firme plantain field is much lower than for a chacra. The slash-weeding of a two year old terra firme plantain field took 19 workdays/ha. Since a plantain field is harvested piecemeal all year long, it is difficult to accurately estimate how much time is spent on harvesting. Farmers estimate that a two year old field yields about 400 racemes. In subsequent years production is lower. Hiraoka (1989b) reports total yields between 1300 and 1800 racemes in similar fields in a village close to Iquitos. Harvesting of 400 racemes for one year would require approximately 20 workdays. Although a single person could harvest more than 20 racemes per day, farmers mostly collect only a few each time they harvest a plantain field, and thus spend relatively more time looking for the produce of a terra firme plantain field.

The produce of a terra firme plantain field is largely sold in the market in Requena, and a small part of it is consumed by the household members (Table 4.1). A terra firme plantain field is therefore principally a cash crop agricultural type, unlike a terra firme chacra. The main risks involved in terra firme plantain fields are low production because of poor soil quality, or low prices in the market.

FOREST GARDEN AGRICULTURAL TYPES

Restinga forest gardens

The restinga forest gardens which were surveyed in Yanallpa are more variable than any other agricultural type described so far. Agroforestry fields are located on both low and high restingas, and their composition and weeding patterns differ considerably. Some forest gardens consist of trees only while in others trees are grown in combination with corn, manioc or plantains.

Padoch & de Jong (1989) point out that work in forest gardens is done very infrequently and only for very short periods. This makes labor investment and production in these fields very difficult to estimate. Moreover, since weeding patterns and species composition of fields are highly variable, the labor input and production levels also vary widely. In chapter seven the variation in species composition and weeding patterns of different forest gardens in Yanallpa will be discussed.

A species found in many Yanallpa agroforestry fields is *Cedrela odorata*. This tree species is native to the floodplain environment and has been incorporated by local farmers in their fields for its marketable timber. Some forest gardens produce tree fruits which are sold in the market, but most products harvested from forest gardens are for household consumption. As reported in chapter three, farmers grew water-sensitive crops in agroforestry fields in the past, but these had all disappeared after the 1986 flood. It can be expected that farmers will plant species like orange, or *Quararibea cordata* again if the high restinga does not flood for several years.

Terra firme forest gardens

Terra firme forest gardens are characterized by a dominant tree vegetation. Most of the Santa Rosa forest gardens were once chacra or plantain fields. However, the term forest garden is used, and not fallow, since these fields continue to be of significant economic importance. Even fields which receive very little attention still contain a large number of individuals of managed species, and yield harvestable products. Managing a field as a forest garden is economically more attractive than complete fallowing, from which it should be distinguished.

Forest gardens on terra firme are as diverse as they are in the varzea. Fields differ in composition and density of managed species, as well as in management patterns. The principal management activities in forest gardens are weeding and harvesting, while in some fields new species continue to be planted. Compared to the other agricultural types, production levels and labor investment are low (Padoch & de Jong 1989).

Although some highly managed forest gardens may be maintained for many years, usually they have a limited life span. At one point, such fields are used again for different agricultural types. The large number of products yielded by forest gardens are primarily destined for household consumption. A few products may be sold in the market (Padoch & de Jong 1989). Very little risk is involved in managing a forest garden since little is invested and not much can be lost. In chapter six the variation in species composition, weeding patterns, and production levels of terra firme forest gardens will be discussed in detail.

OTHER FLOODPLAIN AGRICULTURAL TYPES

Restinga corn fields

Although corn is known as a crop which needs good soil fertility, it has a lower moisture requirement than rice. For one growth cycle, corn requires a minimum rainfall of only 200 mm, which makes it an appropriate crop in regions to dry for rice (Purseglove 1975). This may explain why production levels of restinga corn fields are less variable than of restinga rice fields. On the other hand, ribereño farmers do grow rice in terra firme, where moisture is the limiting factor for this crop. Ribereños do not attempt to grow corn in terra firme fields. The high nitrogen demand of this crop, especially beginning about two months after planting (Purseglove 1975; Cunard 1967a) makes its cultivation unsuccessful unless fertilizers are applied. Although nitrogen is sufficiently available after burning a terra firme field, the available amount of this nutrient becomes limited after a only few weeks (Nye & Greenland 1960, 1964; Sanchez 1973; Jordan 1989; Ewel 1986). Corn is very sensitive to free aluminum caused by a low soil PH (Cunard 1967b), and this makes terra firme fields less suitable for this crop. Farmers in the Peruvian Amazon who do grow corn in terra firme do this in slightly more fertile soils, or use some sort of locally produced green manure (Vickers 1976; 1978; Casanova 1975; Ruddle 1974; Denevan 1971; Johnson 1983; Balee 1984; Brown 1984).

A ripe corn crop does not have to be harvested all at once, but can be left in the field for a considerable period. During this additional period the moisture content of the grain is reduced (Purseglove 1975). Thus harvesting of a corn crop can be scheduled over a longer period than rice, and therefore can be carried out with family labor only. There is less pressure on labor resources of the farming unit when a corn crop is ripe than in the case of a ripe rice crop. Even if a ripe, or almost ripe, corn field is flooded, the yield is not seriously threatened. Therefore, corn can be grown in fields which flood quite early, or two successive crops of corn can be grown in one year in a single field. It is, for instance, common in Yanallpa and Santa Rosa to see farmers standing waist deep in the water, harvesting a corn field.

Planting corn in old restinga fields results in excessive weed growth. Although this may reduce the production (Cunard 1967b), corn appears to tolerate weed competition much better than rice. A restinga field has to dry from one to three months after it emerges from the water, before it can be planted to corn. By the time it is dry, a thorough slash-weeding has to be done to eliminate newly emerged weeds. Corn is then planted using the dibbling technique. After about one month a second weeding is done, but after this second weeding the field is not cleared again until the corn is ripe (Figure 4.1). By that time the field is covered with dense weeds. Ribereño farmers may weed the field before, during, or after harvesting. Bergman (1974) reports that Shipibo farmers usually maintain varzea corn fields free of weeds throughout the growing cycle.

In most restinga corn fields, a second crop is planted immediately after the first has been harvested. The schedule of the first crop is followed again. When ripe, this second crop is weeded to facilitate harvesting as well as to make sure that the field is slash-weeded before it is flooded. Lower restinga fields can be used continuously, but sometimes are fallowed for one or more years if they are not needed (Table 4.1, see also Bergman 1974).

A corn crop may yield as much as 3000 kg/ha of seeds according to local informants. A detailed record of the field of one farmer was kept, who only harvested 1300 kg. The planting of a corn field requires some 10 workdays, and the harvesting 20 to 25 workdays. The first two weedings require some 10 to 15 workdays each, while for the final weeding about 25 workdays must be spent. Post-harvesting corn treatment requires more labor than a rice crop does. The labor input for the production of one single corn crop is about 85 workdays. This is lower than for a restinga rice field. Because of the relatively stable market demand for corn and lower risk as compared to a restinga rice field, corn was the second most important cash crop among Yanallpa and Santa Rosa farmers. The lower risk involved in growing corn in a restinga field corresponds to a lower return for the labor invested, according to the price levels of 1986 and 1987.

Playa cowpea fields

Playas, or the very lowly elevated sand deposits in front of restingas, are out of the water during even shorter periods than barreales are. Peanuts and melons have a growth cycle which is short enough to yield a crop that can be harvested, and they can produce well on the sandy soils (Hiraoka 1985a; Bergman 1974). These two crops are commonly grown by ribereños in other villages, but Yanallpa and Santa Rosa farmers only grew cowpeas on playas during the period of field research. Cowpeas grown for their grains produce a crop in about 90 days (Figure 4.1, Purseglove 1974; Muleba & Ezumah 1985). Furthermore, they tolerate drought and other soil stresses well (Rachi 1985) and are more tolerant than, for instance, *Phaseolus* spp. (Purseglove 1974). Although the latter crop gets a better market price than cowpeas, they are not grown in playa fields because of their difficult production.

Taking care of a cowpea field is mainly a woman's responsibility. Playa fields are planted immediately after they emerge. Cowpeas are planted by making a small hole with a *machete* and dropping several seeds in it. The broadcasting technique, common in Africa (Purseglove 1974), is not used. Playa cowpea fields are not weeded, since fields appear after the flooding season free of weeds and without a soil seed bank. Weed competition, or pests, which are the most common causes of low cowpea yields in Africa (Rachie 1985; Muleba & Ezumah 1985) are absent.

The entire pods of the cowpea crop are harvested in the field, and are shelled at home. The total yield of shelled cowpea may reach 700 kg/ha for a single crop (Table 4.1, Hiraoka reports 0.6 to 0.9 metric tons), which compares favorably to levels of 200 to 300 kg/ha reported for cowpea yields of small farmers in Africa (Purseglove 1974; Rachie 1985; Muleba & Ezumah 1985). Cowpeas are grown for both market sale and household consumption. Since this crop does not have a guaranteed market price, it is grown much less frequently than rice or corn. However, cowpeas can be stored for a long time, and farmers usually conserve some of a previous harvest at home as a protein source when fish are scarce. Farmers seldom risk growing cowpeas on sites liable to flood before the crop can be harvested because of its limited economic importance.

Restinga jute fields

Restinga jute (*Urena lobata*) was only produced during the second interview period in Santa Rosa and Yanallpa. This agricultural type is found in many other places and farmers of the two villages studied reported to have grown it before (see chapter three). Jute was replaced by rice and corn as the principal cash crop around 1970. Growing jute is disliked by farmers since the crop has to be processed while standing in the water, which is considered unhealthy. During the time of research, however, a controlled price and the availability of bank loans for jute production persuaded many farmers to return to jute growing.

Jute is planted by broadcasting seeds on restinga about one month after a field dries. Only one slash-weeding is required to get rid of the competing weeds. After seven to nine months, often when the field is already flooded again, the crop is harvested. The harvested jute is left in the water for 18 to 20 days so that the plants rot. Then the plants have to be washed and beaten thoroughly so that only the fibers, or the sclerified covering of the vascular bundles, remain. Subsequently the fibers are dried on poles, and rolled up in bundles. These bundles are very heavy, and difficult to transport.

Labor requirements are about three workdays for broadcasting the jute seeds. The weeding takes about 10 workdays. Harvesting, washing, drying and rolling the jute require about 45 to 50 workdays (Bergman, 1974; Pinedo pers.com.). Often farmers employ hired labor for jute production.

Restinga vegetable fields

Only very little information could be obtained about growing vegetables in a restinga field. During the first interview period only one farmer in Yanallpa reported a restinga vegetable field. The vegetables grown in this agricultural type included tomatoes, several peppers, cucumbers and *Cyclanthera pedata L.* These are species grown only in medium to low elevated restinga fields which have more loamier soils than fields on the higher restinga do. Once these fields fall dry they are totally cleared and planted. Vegetable production continues until the field is flooded again. Since quite a few vegetables planted have cycles of only two to three months, several crops may be grown during one season.

Weeding activities in a vegetable field are carried out at least twice a week, if not more often. Different products are harvested at different times. Restinga vegetable gardens require very intensive monitoring and are mainly a cash crop venture (Table 4.1). Like the playa cowpea agricultural type, restinga vegetable fields are mainly managed by women. The main risks are loss of crops to pests or diseases, and low market prices.

CHAPTER FIVE

VARIATION IN AGRICULTURAL STRATEGIES

INTRODUCTION

In chapter four it was discussed how ribereño farmers respond to the ecologically diverse landscape and economical diverse market opportunities by farming a large number of agricultural types. Ribereño agricultural complexity is further increased by the individual responses of farmers to such large numbers of available options. Few Santa Rosa and Yanallpa farmers follow the same agricultural strategy in making a living. Furthermore, ribereños display tremendous flexibility in adapting to new circumstances, and they constantly modify their resource management strategies in response to the changing conditions of the physical and economic environment. Ribereño agricultural strategies indicate how these farmers adapt to the complexity of the environment in which they live.

In chapter one agricultural strategies were defined as: agricultural choices in the allocation of limited resources (land, labor, capital) on which farmers rely to meet their subsistence needs, including needs for cash. Studies on agricultural strategies essentially try to explain certain styles of agricultural behavior of a delimited group of farmers. To be able to do so, it is assumed that farmers make individual agricultural choices, but also that there are certain explicit reasons for making such choices. It is assumed that specific external factors exercise selective pressure upon the decisions which farmers take. Such factors are, for instance, access to land, labor and capital, access to markets, price levels for products, and levels of risk and uncertainty carried by certain choices (Barlett 1980a,b, 1982; Cashdan 1990; Cancian 1989; Roseberry 1989). Understanding the mechanisms of the influence of such factors on agricultural behavior of farmers, allows for explaining and understanding agricultural strategies.

Ribereños make agricultural choices, for instance, when they want to make a new field. In such situations a decision has to be made as to the agricultural type of this new field. The factors in such a situation which influence this choice are access to land, availability of labor resources, and availability of capital. The purpose of the present chapter is to demonstrate the variation in agricultural strategies among farmers in Santa Rosa and Yanallpa, and to attempt to explain this variation.

The agricultural strategies of the inhabitants of Santa Rosa and Yanallpa are evaluated by assessing the combination of agricultural types which farmers had at a specific moment. A choice for a certain agricultural type implies the allocation of limited resources. A certain combination of agricultural types is the result of several previous decisions on resource allocation. Hence the combination of agricultural types is an appropriate criterion for the evaluation of farmers' agricultural strategies.

As in agricultural diversity, the variation in agricultural strategies among ribereños is remarkable. General agricultural strategies were quite different between Santa Rosa and Yanallpa, principally a result of the different farming environments in each village. However, the variation in agricultural strategies within each village was equally large. Diversity, rather than similarity, appears to be the rule. Furthermore, very few farmers maintain the same agricultural strategy over a long period. Some ribereños change their way of farming fundamentally within a time span of only a single year. Such changes are responses to new opportunities, or new conditions in the ecological or economic environment.

FACTORS INFLUENCING RIBEREÑO AGRICULTURE

In order to conduct an analysis of agricultural strategies, a few principles should be accepted, which are true for small farmers in general. First, we assume that ribereños are rational economic actors who operate in fundamentally similar ways, but who experience a specific economic environment that limits their options (Barlett 1980b). Second, all ribereños try to match households needs with the resources available to them. Third, choices are made by single farming units within the cultural and institutional environment in which they are located. These principles can be summarized as: since each farming unit has its own specific needs and resources, and since natural and socioeconomic environments are variable, agricultural strategies are individualistic and may vary over periods of time.

For the case of ribereño agricultural behavior, six factors can be distinguished which directly influence agricultural choices, and therefore agricultural strategies. (1) One of the basic factors is the need to find an adequate **balance between production for household consumption and cash cropping**. Ribereños, like so many other small farmers, seek to fulfil two goals in their agricultural activities. On the one hand they want to produce their own food, while at the same time they depend largely on agricultural production to provide cash needed to buy goods and services they cannot produce themselves. Although ribereños do indeed wish to ensure a steady food supply (Chibnik 1990: 299) this does not diminish the importance of the second goal. Chapter four shows that household production and cash cropping each partly depend on different agricultural activities, and most farmers have both kinds of agricultural types. It is, however, not unusual that farmers employ only agricultural types that produce either mainly for sale or mainly for household consumption.

(2) The principal factor which influences the kind of commercial agriculture ribereños will undertake, provided a sufficient ecological basis exists, is the **opportunity to sell products at a good profit**. Santa Rosa and Yanallpa farmers market most of their agricultural products in Requena. At the time of this research rice could be sold at government buying centers. Although a government corn buying center did exist in Requena, it seldom operated, and most farmers sold corn to private companies or intermediaries. Jute could also be sold at government buying centers. Prices for rice, corn and jute approximately followed increasing inflation rates between 1985 and 1987 (Chibnik 1990). All other products sold by farmers had prices established by market forces. Prices for products which do not have a controlled price may vary tremendously within very short periods (Padoch 1988, 1992; IPA 1977). Usually farmers sell such products to intermediaries in the market in Requena, or even to buyers in the village. They also sometimes ask boat owners in the village who are going to Requena, to sell small quantities of

products for them.

(3) The third factor which influences economic behavior of ribereño farmers is the **risk involved with agricultural activities**. Risk is defined here as the probability of a loss or hazard (Cashdan 1990). In chapter four the risk of each of the fourteen agricultural types has been indicated. Although ribereños reduce risk as much as possible they do not avoid risky choices if this may be rewarded with the possibility of a relatively high payoff. In fact, as demonstrated below, the most popular cash cropping activity in Santa Rosa was growing rice in a barreal, quite a risky option as explained in chapter four. Rather than avoiding or minimizing risk, ribereños seek "satisfactory amounts of both profit and risk" (Chibnik 1990: 281).

(4) A factor which influences ribereño agricultural strategies is **access to land.** Land is often considered to be unlimited in Amazonia with its low population density. In chapter three it has been explained why this is not generally true. Certain varzea landforms are more appropriate for certain crops than others, and access to these lands determines the agricultural type a farmer can opt for when deciding to make a new agricultural field. Furthermore, the specific location of land is also important. Farmers may maintain rice fields in barreales even on locations outside of the village area. However, if new, still uncultivated terra firme land is located at a long distance from the village, than farmers may decide to slash a terra firme forest garden while it is still young and convert it into a chacra. Alternatively they may make a chacra in the floodplain.

(5) The next important factor in farmers agricultural decision-making is the **availability of labor**. Among ribereños, both men and women engage in agriculture. Children already participate at an early age in household and farm work, but, in most analyses of family labor, only members fifteen years old or older are considered full participants in the agricultural activities. Ribereño farmers generally use their labor pool to expand agricultural activities, but excessive labor may also be allocated to other, non-agricultural production. Moreover, farming units may differ significantly in the amount of work they accomplish with a similar labor pool (Barlett 1982).

(6) Directly related to the availability of labor is the influence of **access to capital** on farming strategies. Ribereño farmers obtain extra-family labor by holding festive labor parties, or participating in labor groups (Chibnik & de Jong 1989; de Jong 1987). For some specific labor-demanding occasions farmers have to hire extra-family labor, and, during the time of field work, they often rely on bank loans to obtain the cash needed to pay workers (Chibnik 1990). Criteria for eligibility for loans from the Agricultural Bank changed very much between 1985 and 1989.

DATA SETS USED AND METHOD OF DATA-ANALYSIS

Both quantitative and qualitative methods can be used to analyze how the above factors influence agricultural strategies. If decision-making processes are the focus, participant observation and ethno-scientific interviews are more important (Chibnik 1980). Such methods allow for an evaluation of specific alternative choices by breaking those down into a hierarchy of sub-choices which can be related to certain key-factors. The decision-making process can then be represented with the use of a decision tree or flowchart (e.g. Gladwin & Murtaugh 1980; Barlett 1977; Chibnik & de Jong 1989).

If the principal scientific interest of the research is to explain the variation in agricultural strategies of a certain group of farmers, then an alternative method is to relate certain characteristics of subgroups of farmers to certain kinds of agricultural strategies. The characteristics which can be used to subdivide, or stratify, the group of farmers are, for instance, the family labor pool, and the access to land or capital. If the latter approach is followed, standardized questionnaires are often used to obtain quantitative data, and the results are analyzed using statistical procedures. However, a profound familiarity with the daily life of the farmers remains necessary to allow adequate explanations of the results. Although etho-scientific interviews and participant observation were methods also used in the research, the following analysis mainly follows the second approach.

The variation in agricultural strategies among farmers in Santa Rosa and Yanallpa was analyzed by comparing the specific combination of agricultural types within each farming unit. First, the frequency of each of the agricultural types reported by farmers is analyzed. This provided a general indication of the differences in agricultural strategies between the two villages. Second, the number of agricultural types reported by individual farming units were compared. According to need, potential, and preference, each farming unit has a specific number of agricultural types. This is highly indicative of agricultural strategies of individual farmers. Third, the discussion of changes in the number of agricultural types and combination of agricultural types between 1985/1986 and 1989, reported by individual farmers, demonstrates changes in agricultural strategies during this three year period.

The answers from the general surveys conducted in 1985 in Santa Rosa, in 1986 in Yanallpa, and in 1989 again in both villages were used as the principal data set for the discussion in this chapter. The farmers within each village were subdivided (statistically stratified) into groups according to certain differences in agricultural strategies, or combination of agricultural types. Next it was calculated whether or not the averages of a number of socioeconomic characteristics of the whole group of farmers differed significantly between these subgroups. If this was the case, it implied that the specific variable probably was a factor of importance in differentiating the agricultural strategy in question. A t-test was used for this procedure.

Differences in agricultural strategies which were tested against socioeconomic characteristics were, for instance, whether or not farmers reported practicing one of the principal agricultural types. A second stratification criterion was made between farmers who had three or less agricultural types, and those who had more than three. Means were calcultated for variables like: the number of household members, or members who were 15 years old or older, the number of years farmers had lived in the village, or how long farmers had been using bank loans. Means are reported when they were significantly different at a one tailed t-test significance level of 0.05 or less. Together with the means the *one-tailed t-test probability* is reported as @ *value* i.e. the chance that the noticed difference in means would occur under the situation when they are, in fact, not different. In the analysis of data, and its subsequent explanation, the results of the extensive interviews, and findings from participant observations, are also used.

In Santa Rosa members of 46 farming units were interviewed in 1985, and members of 47 farming units in 1989. Out of the 47 farmers surveyed in 1989, ten had not been interviewed in 1985; some were new immigrants, others newly established farmers. Out of the 46 farmers who were interviewed in 1985, seven had left the village, and two farmers could not be located in 1989. There remained only 37 farmers for whom the agricultural strategies for both 1985 and 1989 could be compared. In Yanallpa 50 farmers were interviewed in 1986, and 68 in 1989. Of the 68 farmers surveyed in 1989, 19 had not been interviewed before. Nine farmers who lived in Yanallpa in 1986 had left the village by 1989. For only 41 farmers could the agricultural strategies be compared both in 1986 and in 1989.

RESULTS

Frequencies of agricultural types in 1985/1986

As shown in Figure 5.1, Santa Rosa farmers managed 12 agricultural types in 1985. The terra firme agroforestry field and the terra firme chacra were the most common ones, found among 32 (70%) and 29 (63%) farmers respectively. The high frequency of these two low-risk, household-oriented agricultural types sustains Chibnik's (1990) observation that ribereños always try to assure their food supply first, regardless of whether they take higher risks in cash cropping. A total of 10 farmers (22%) had a terra firme chacra together with a restinga chacra. However, a surprising 11 Santa Rosa farmers (24%) did not manage a terra firme chacra, but a restinga chacra instead. These farmers either lived in the floodplain, or temporarily located almost all of their agricultural activities there. Farmers who lived on the terra firme hillock, and who had no terra firme chacra in 1985, all made such an agricultural field between 1985 and 1989. Only six farmers (13%) in Santa Rosa had neither a terra firme chacra, nor a restinga chacra. Their households had fewer members (3.9 versus 6.9; @ = 0.018) as well as fewer members

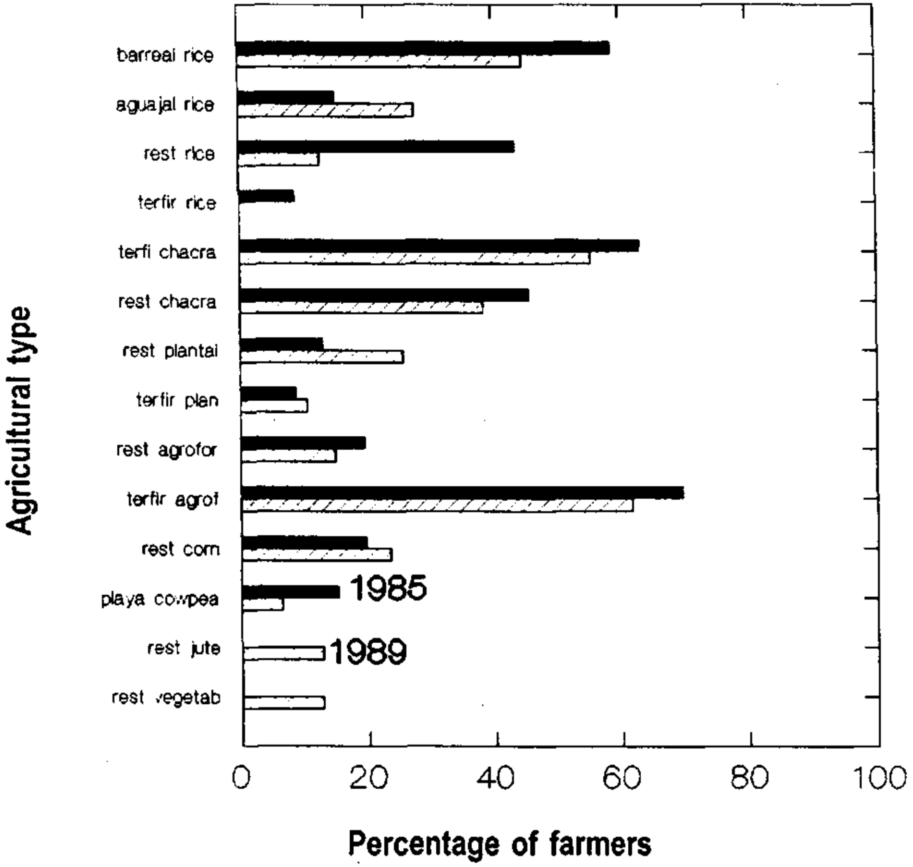

Figure 5.1: Percentage of farmers in Santa Rosa who reported to farm the listed agricultural types in 1985 and 1989.

over 15 years old (2.1 versus 3.3; @ = 0.009). Several of them also lived outside the village most of the time, had only recently left their family to become independent farmers, or were engaged in other productive activities outside agriculture.

The high proportion of the 39 farmers (85%) in Santa Rosa managing at least one rice agricultural types reflects the importance of rice as a cash crop, and probably also as a source of cash credit, during the time of research (Chibnik 1990). However, only 27 farmers (59%) had a barreal rice field. Both in 1985 and 1989 farmers who possessed a usufruct certificate for a barreal had been living in the village longer than those who did not have such a certificate (18 years versus 11.4 years in 1985; @ = 0.122, and 18.8 years versus 8.6 years in 1989 @ = 0.001). Barreales are the most favored cash cropping sites, and access to this landform is only available to a limited number of farmers because it is limited in area. In order to gain access to barreales, farmers have to buy the right of usufruct from another farmer, or to occupy a newly appearing barreal site, and it can take years before an opportunity to do so occurs.

Not all farmers had access to a barreal and therefore some grew rice in a restinga or aguajal field. However, some farmers who had barreal rice fields, also had one or more other types of rice agricultural types. Of the 20 farmers (44%) who had a restinga rice field, nine also had a barreal, and of the seven farmers (15%) who had an aguajal rice field two also had a barreal rice field. Generally, only young farmers managed an aguajal rice field but had no barreal rice field both in 1985 (age 34.2 years versus age 41.0; @ = 0.123) and in 1989 (age 26.8 versus age 49.2; @ = 0.000). Since for producing rice an aguajal is the second best alternative to growing it in a barreal, younger farmers who did not yet have access to a barreal would prefer this alternative. The fact that only seven farmers managed an aguajal rice field in 1985, while in 1989 a total of 13 did so was a result of the extremely low flood in 1985 which prevented five farmers from using their aguajal fields that year. Only four farmers (9%) produced rice in a terra firme field, and two of those had a barreal rice field at the same time.

The most notable difference in general farming strategies between Santa Rosa and Yanallpa was the absence of any terra firme agricultural types in the latter village, a result of the difficult access to terra firme. Some Yanallpa farmers reported that they had owned fields on the Santa Rosa terra firme hillock around 1970, but had abandoned them because of the long traveling time needed to reach those fields. Yanallpa farmers managed only eight agricultural types in 1986. The most common agricultural type was the restinga chacra, which was in use by 44 of the farmers (88%, Figure 5.2). Although this number is much higher than the 29 Santa Rosa farmers (63%) who managed a terra firme chacra, it is not very different from the 40 farmers (87%) in Santa Rosa who had either a terra firme, or a restinga chacra, or both. Yanallpa farmers, like those in Santa Rosa, subsist on their own food production. Those who had neither a restinga chacra nor a plantain field in 1989 lived, most of the time, outside the village, or were single-member farming units. Others had recently become independent farmers, were new residents, or were farmers who obtained sufficient income from cash cropping or other work to buy the staples they needed.

Agroforestry fields, on the other hand, were much less common in Yanallpa (34%) than in Santa Rosa (70%). The 1989 data showed that heads of farming units in Yanallpa who had a restinga agroforestry field, tended to be older (50.1 versus 37.7; @ = 0.013) and had lived longer in the village (28.3 versus 11.1, @ = 0.003). Since there is less of an ecological need to establish agroforestry fields

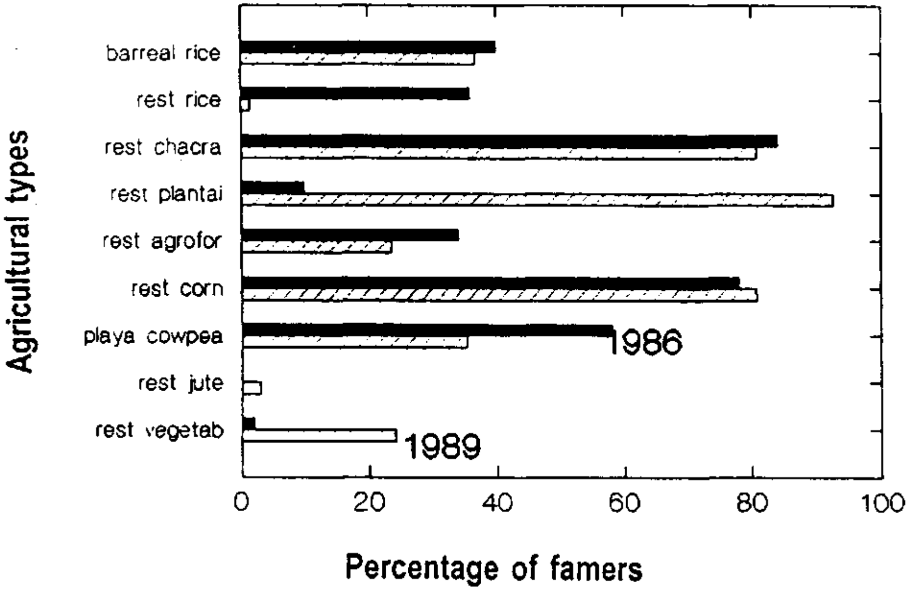

Figure 5.2: Percentage of farmers in Yanallpa who reported to farm the listed agricultural types in 1985 and 1989.

in the floodplain than on terra firme, fewer farmers are willing to dedicate land to tree production. Perhaps this is because land pressure has increased over the last decades and only older farmers, who had had these fields longer still maintained agroforestry fields.

The very low number of five Yanallpa farmers (10%) who had restinga plantain fields in 1986 does not reflect the relative importance of this agricultural type. Almost all the plantain fields were destroyed that year because of the high flood, and farmers were replanting their high levee fields. Many farmers, at that time, used the sites, usually planted to plantains first, for other agricultural types, while they were restoring the plantain crop. This explains why there were 18 farmers (36%) who had a restinga rice field in 1986, while in 1989 only one did so. In 1989, the restinga plantain field had become the most common agricultural type in Yanallpa, where it was found in 63 of the farming units (93%).

Another noticeable difference, between the two villages studied, was p the emphasis on different cash crops. In 1985/1986, Yanallpa, 39 farmers (78%) grew corn in restinga, while only 34 farmers (64%) had one or more types of rice fields. Another conspicuous difference between the two villages was the number of farmers who grew cowpea on playa land. A total of 29 Yanallpa farmers (58%) had such a field, as contrasted with only seven Santa Rosa farmers (15%). The access to land, i.e. the large playa in front of Yanallpa, explains this difference.

Changes in utilization of agricultural types

In 1989 Santa Rosa farmers managed a total of 12 different agricultural types, the same number as in 1985. Nonetheless important changes had occurred in the kind of agricultural types which farmers preferred. The most striking change in agricultural strategies in Santa Rosa was the decline in rice production. Only 28 of the Santa Rosa farmers (60%) planted rice in 1989, a decrease of 25.2% since 1985 (Figure 5.2). None of the farmers grew rice in terra firme in 1989 while only 6 grew restinga rice. The decrease in the number of farmers growing rice in barreales from 27 to 21 was caused by the reduction of the total area of barreal in the village.

Other cash crop agricultural types increased in importance in Santa Rosa between 1985 and 1989. More farmers (11, 23%) grew corn in a restinga field, and Santa Rosa farmers practiced two new agricultural types: restinga jute fields, and restinga vegetable fields. In the latter, mainly beans were grown. Both agricultural types were found in 6 farming units (13%). Since none of the farmers

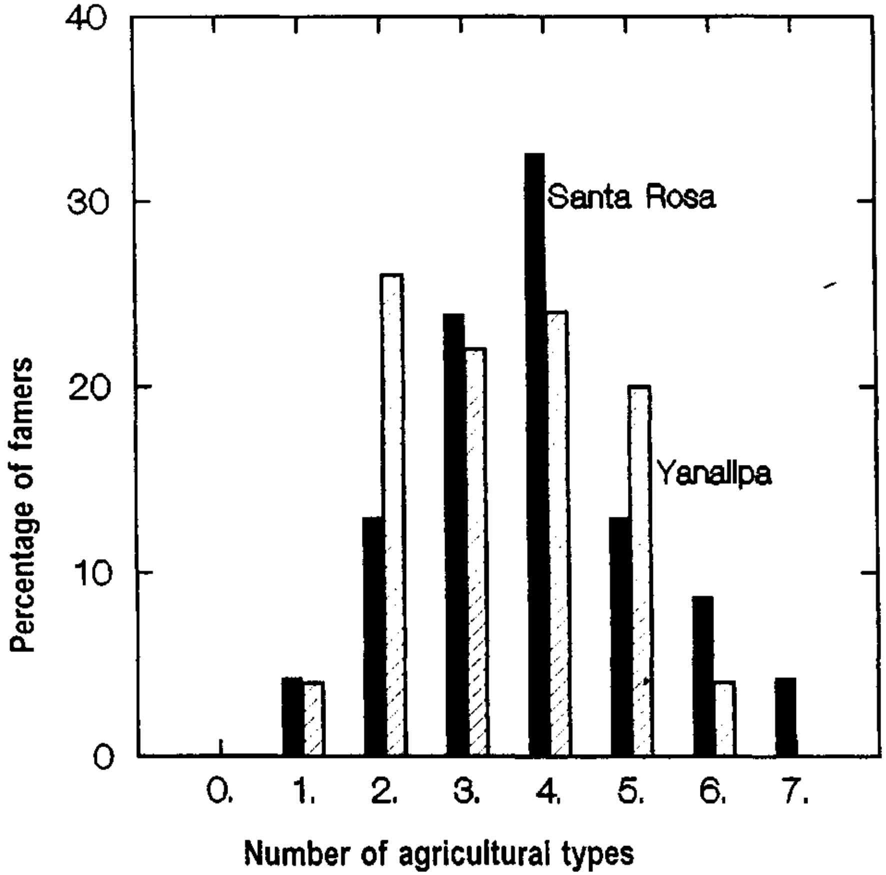

Figure 5.3 Distribution of farming units according to farm size, expressed in number of agricultural types per unit, in Santa Rosa and Yanallpa, 1985/1986.

had both of the new agricultural types, 12 farmers (26%) chose a new cash crop activity in 1989. The number of farmers who grew plantain in restinga fields increased from 6 to 12.

In Yanallpa all farmers managed nine agricultural types in 1989, compared to only eight in 1986. A decline in rice production, similar to that observed in Santa Rosa, occurred in this village. As mentioned above, the number of farmers who managed a restinga rice field especially decreased. The number of farmers growing rice in barreales increased from 20 to 25. The absolute number of farmers who managed restinga corn fields and restinga chacra fields increased between 1986 and 1989, but in both years they represented around 80% of farmers in the village. The most dramatic change in the agricultural behavior of Yanallpa farmers, however, was the increase in farmers growing plantains, as explained above.

Magnitudes of farming enterprises

In Santa Rosa, in 1985, the average number of agricultural types per farming units was 3.8. A total of 32 (70%) farmers managed between three and five agricultural types. The highest number of agricultural types managed by a single farming units was seven, reported by two farmers. The lowest number reported, also by two farmers, was one (Figure 5.3). In 1989 the average number of agricultural types per farming unit had decreased from 3.8 to 3.6. That year, more farmers managed only three, instead of four agricultural types, and fewer farmers managed six or seven agricultural types than four years earlier (Figure 5.4).

Although a comparable number of Santa Rosa farmers managed one or two agricultural types in 1985 and in 1989, they were mostly different farming units. In 1985, farmers who had two or less agricultural types had taken bank loans for an average of 2.4 years, while farmers managing three or more agricultural types had an average of 7.4 years of bank loans (@ = 0.017). Bank loans are mainly used to increase the labor capacity by paying hired workers, and the number of agricultural types practiced by one farmer therefore appears to be directly related to the amount of labor available. All farmers who managed fewer than three agricultural types in 1985, in 1989 either had left the village, or had increased their

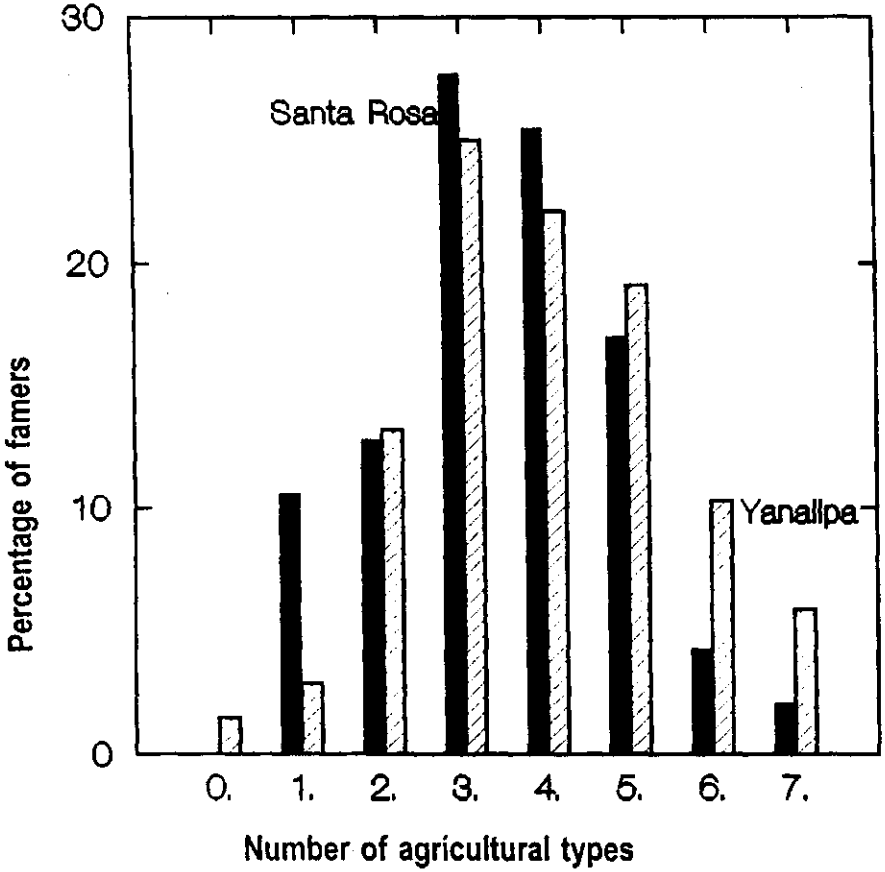

Figure 5.4 Distribution of farming units according to farm size, expressed in number of agricultural types per unit, in Santa Rosa and Yanallpa, 1989.

number of agricultural types. One farmer who decreased the number of agricultural types from three to two, was reported to have had a serious illness in his family.

In 1985 some stratification could be noticed among farmers who managed five or more agricultural types. They had an average of 9.5 years of using bank loans, whereas farmers who managed four or less agricultural types only had an average of 5.2 years of bank loans (@ = 0.026). This again can be explained in terms of farmers who have bank loans being capable of hiring extra-family labor, and therefore able to increase the number of agricultural types in their enterprise. In most cases the farmers with five or more agricultural types had a lower number in 1989. In some of these farming units household members had left, or they now focused on other non-agricultural work.

In Yanallpa, in 1986 farming units managed an average of 3.4 agricultural types, a number slightly lower than that in Santa Rosa. Only two farmers had six agricultural types, and two farmers had one agricultural type (Figure 5.3). In 1989, however, a shift towards more complex combinations could be noticed (Figure 5.4). The average of agricultural types per farming unit increased from 3.4 to 3.9, a number even higher than in Santa Rosa in 1985. The number of farmers managing six agricultural types increased from only two (4%) in 1986 to seven in 1989 (10%). The number of farmers managing seven agricultural types increased from zero to four (6%) in the same period. The lower average number of agricultural types per farming unit in 1986 is a result of the flooding of the whole Yanallpa area which had destroyed many agricultural fields that year. For instance, few farmers reported restinga plantain fields in 1986. One new Yanallpa inhabitant in 1989 reported to have no agricultural fields at all, since he had only very recently arrived in the village.

In Yanallpa in 1986 farmers with two or less agricultural types had fewer farming unit members (5.3 against 7.2; @ = 0.028), and fewer members who were fifteen years or older (2.1 versus 3.3; @ = 0.004). In 1989 farmers with two or less agricultural types still had both fewer farming unit members (2.8 versus 5.8; @ = 0.000), and fewer members fifteen or older (1.6 versus 2.9; @ = 0.001). Again the complexity of farms appeared to be directly related to the availability of household labor. On the other hand, all the farmers in Yanallpa who managed one or two agricultural types in 1986 increased the diversity of their enterprise in the following years. Farming units with fewer household members may have less than the average number of agricultural types, but only temporarily.

Farmers in Yanallpa who had five or more agricultural types in 1986 had been working longer using bank loans (5.8 years versus 2.2 years; @ = 0.025). It is remarkable that several of the farmers in Yanallpa who managed six or seven agricultural types in 1989 had managed only one or two in 1986. Except for one case, they all had inherited fields from a parent who had left the village for Iquitos.

The most exemplary indication of the complexity of agricultural strategies among Santa Rosa and Yanallpa farmers is the variation observed in combinations of agricultural types. In Santa Rosa in 1985 a total of 39 different combinations of agricultural types occurred. In 1989 among the 47 farmers 43 different agricultural type combinations were found. In Yanallpa, in 1986, among the 50 Yanallpa farmers 29 different combinations of agricultural types were observed, and in 1989 this number had increased to 44 combinations among 68 farmers.

Changes in agricultural strategies

Between 1985 and 1989 Santa Rosa farmers increased or decreased the number of agricultural types they managed by between zero and three types. The most common change in number of agricultural types was three. Farmers who had changed most were those who had either very few, or numerous agricultural types. Again this indicates that farmers may have more or less than the average number, but after some time will return to those average numbers. In Yanallpa, farmers increased or decreased the number of agricultural types they managed by between zero and four types. The largest groups of farmers, however, had the same number of agricultural types both in 1986 and 1989 (Figure 5.5).

The changes in the specific combination of agricultural types of individual farmers between 1986 and 1989 were much larger in the two villages. Farmers, both in Santa Rosa and Yanallpa, sometimes replaced up to three agricultural types with three others between 1985/1986 and 1989. No stratification could be detected among farmers according to the changes in combinations of agricultural types. However, the following two examples illustrate what could motivate farmers to change their agricultural strategies.

One farmer in Santa Rosa had replaced four out of the five agricultural types he managed in 1985 with three others by 1989. He had abandoned his barreal rice field since this was not suitable for rice growing anymore. In 1989 he had a cowpea field on the same location. The corn he grew in a restinga field had given him unsatisfactory returns, and in 1989 he made a new restinga jute field. Furthermore this farmer had been sick for a long period in 1988 and had not been able to maintain his terra firme chacra. This field was overgrown with secondary

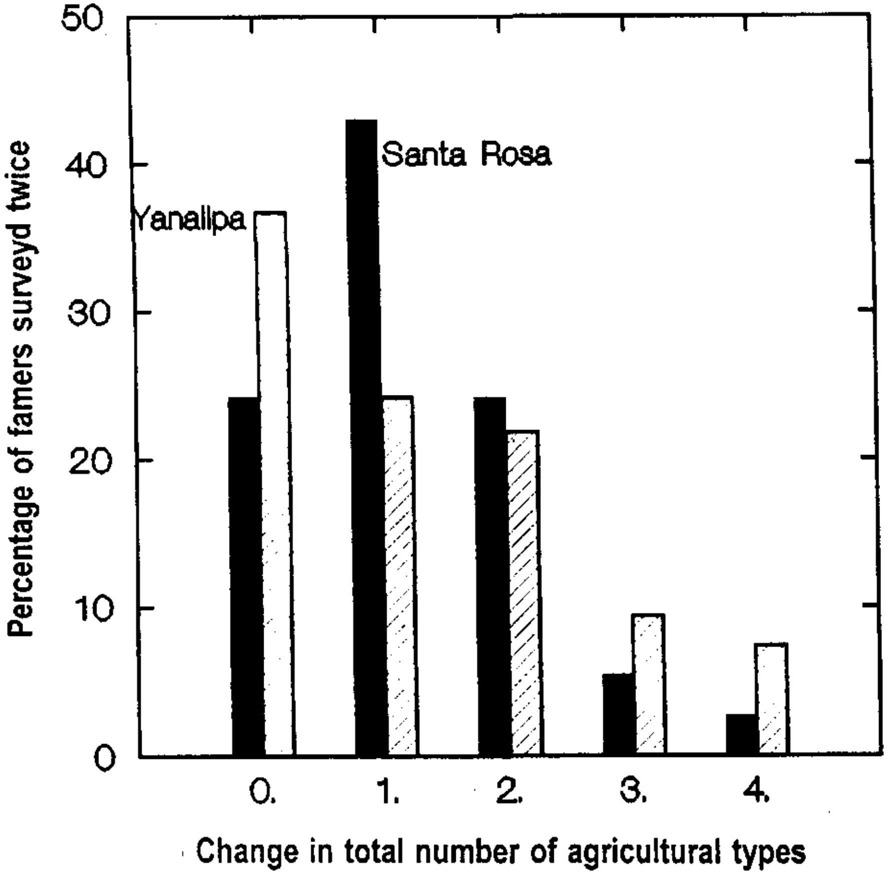

Figure 5.5 Distribution of farming units according to changes in farm size between 1985/1986 and 1989, expressed as increase or decrease in number of agricultural types per unit.

vegetation. The farmers had also lost a small restinga plantain field to the flood in 1986, which had not been replanted.

One Yanallpa farmer managed five agricultural types during both interviews, but had replaced three that she managed in 1986 with three others by 1989. In 1986 she lived and worked together with her husband, who left the village in 1987. The woman continued to farm on her own with only the help of her children and using extra-family labor. To finance hiring laborers, or organizing labor parties, she started selling liquor and groceries at home. She abandoned the barreal field which had become too sandy, and her cowpea field because it was located to far from her house. She had started growing vegetables on the restinga field, which in 1986 had been used for rice growing, and began to grow corn and plantain in restinga fields. She maintained a restinga chacra, and an agroforestry field.

DISCUSSION

Preferred farming strategies

The distribution of numbers of agricultural types per farming unit in Santa Rosa suggests that an inhabitant of this village preferably farms simultaneously three to five agricultural types. The frequencies of agricultural types indicate that a farmer is most likely to manage a terra firme chacra, a terra firme agroforestry field, and a barreal rice field. In Yanallpa a preferred agricultural strategy consisted of three to five agricultural types, but would include a restinga chacra, restinga plantain field, and restinga corn field. In Santa Rosa production for household consumption stems mainly from the terra firme chacra. In Yanallpa, both restinga chacra and plantain fields provide food. The latter combination increases the security of the staple supply. The differences in barreal rice versus restinga corn production, as the main cash crop activity, is a result of ecological differences in the two villages. Under certain circumstances ribereños may have either fewer, or more agricultural types, than the preferred three to five agricultural types.

The number of agricultural types managed by farmers may be influenced by temporarily ecological factors, as was the case in Yanallpa 1986 when an extremely high flood had destroyed all plantain fields. The principal factor which determines the number of agricultural types of a single farming unit is the amount of labor available. Especially in Yanallpa, a direct relation appeared between the labor pool of a farming unit and the number of agricultural types that were managed. Also, those farmers who had made longer use of bank loans appeared to manage more agricultural types. This effect can also be explained as the result of labor availability, since such farmers are more accustomed to hiring workers. In most cases farmers who are permanent residents in the two villages only maintain unusually high or low numbers of agricultural types for a short period of time, and soon change back to more usual numbers.

Several other factors explain why farmers managed fewer than three agricultural types. Ribereños are very mobile (Padoch 1986) and in any community a number of recent immigrants are always found, who are still establishing their farm enterprise. In addition, a number of farmers are often about to leave the village, and therefore already have abandoned certain agricultural types they managed before. Young villagers may have recently become independent farmers, or they may be only single member farming units, and thus able to manage fewer agricultural types. Other farmers may be engaged in other productive activities, or live for part of the year outside the village. Sometimes farmers specialize in only one or two agricultural types, for instance the farmers who managed large areas of barreal rice fields.

The main reasons why farmers want to change the number of agricultural types they manage at a certain time is because they have either too few or too many. Farmers may be overly ambitious at certain moments and try to increase their production beyond what the farming unit can handle. Sometimes a high number of agricultural types may reflect a transition period in which a farmer is trying out new agricultural types, whereas his old ones have not yet been completely abandoned.

Household production

Whether or not ribereños will follow the strategy with the lowest risk to produce their own food, depends, more than anything on a personal willingness to take risk. Most Santa Rosa farmers relied on a terra firme chacra for their basic food supply during the two survey periods. A number of farmers, however, obtained their staple food from a restinga chacra. This means that they accepted higher risk in return for easier access to other restinga fields and to the river. The location of terra firme lands and arable varzea land within such a close distance is rather unusual in the Peruvian Amazon. In many other villages ribereños have no other choice than to locate all their agricultural activities in the floodplain, including their food production.

Many Yanallpa farmers obtain their principal staple food from both a restinga chacra and a restinga plantain field. The high number of farmers who had both of these agricultural types in 1989 indicates that they do not substitute, but rather complement each other. Combining a restinga chacra and plantain field increases food security, but also allows Yanallpa farmers to increase cash returns. A restinga chacra usually yields manioc for about four to six months per year. A plantain field yields plantains during most of the year, and surplus production can be sold. Plantain fields, however, will certainly be destroyed if they are flooded, and farmers consider it risky to only rely on this agricultural type for their food supply.

Rice versus corn cash cropping

The preference of rice as a cash crop among Santa Rosa farmers versus a much stronger emphasis on corn cash cropping in Yanallpa is a result of the different ecological conditions in the two villages. Santa Rosa farmers have access to a large area of barreal, and between 1985 and 1989 concentrated most of their cash cropping activities on this landform. Santa Rosa farmers also have access to the aguajal, a biotope which is suited to rice production. Furthermore, much of the lower restinga in this village was, until 1986, still covered with high forest, and hence new fields could still be opened there for rice production.

Barreales are, without doubt, the most preferred rice production agricultural sites. Since these lands are scarce, new farmers have to begin by growing rice on different land forms, or by producing other cash crops until they have the opportunity to buy an existing barreal site or to occupy a new one. If a farmer has sufficient labor available, this labor may be invested in a second or a third cash crop agricultural type. Such a choice is also taken to reduce the risk of crop failure from one cash crop agricultural type.

In the close vicinity of Yanallpa, a much smaller area of barreal terrain than in Santa Rosa emerges every year. While barreal rice production is important in Yanallpa, it is an additional cash crop activity, rather than the main source of monetary income. Much of the lower restinga terrains in Yanallpa are located on the back slope of the principal levee (see chapter three) and already had been used for many years. Weed competition makes these sites inappropriate for rice growing. A few areas of restinga on the left river bank still were covered by high forests, which were being converted by some farmers to rice production. The larger part of the Yanallpa lower restingas, however, is better suited to growing corn.

The decline in rice production in Santa Rosa and Yanallpa was mostly a result of a fewer farmers growing rice in restinga fields. The conditions for growing rice in restinga fields were good in 1985/1986 in the two villages. In Santa Rosa the shift of the Ucayali river had resulted in increased sedimentation of the lower restinga area on the right bank, downstream from the village center. Santa Rosa farmers had increasingly been using this lower restinga land for rice production. By 1989 most new restinga sites in Santa Rosa had been deforested. In Yanallpa the high flood of 1986 caused favorable rice growing conditions on many higher restinga sites. Because no recent flooding had occurred which had rejuvenated the medium and higher elevated restinga sites in Yanallpa, rice was less planted on these lands.

A second explanation for the decline in restinga rice growing was the changing services of the government agencies in charge of regulating rice production. Obtaining bank loans from the Peruvian Agrarian Bank for restinga rice production used to be difficult, especially for new applicants, and the administrative processes were tedious and time consuming (Chibnik 1990). After the APRA government came into power in 1985, they improved both credit policies, and services of the agencies in charge of buying rice from farmers, which increased rice production in restinga fields. However, three years later, when the economic policies of the new government had largely failed, services of the government agencies again worsened. Farmers sometimes had to wait for several months to get paid for products they had delivered. These declining services for rice producers depressed rice production in restinga fields, since profits from this agricultural type are smaller than from barreal or aguajal rice fields.

Many of the Santa Rosa farmers who had grown a barreal in 1985, but were not doing so in 1989, grew a cowpea field in that year, mainly on the sites where the barreal had been located before. This not only provided an alternative income, but also allowed the farmer to maintain the user's right over the site, in the hope that the quality will improve again in following years. Since in Yanallpa barreales appeared in different locations in 1989 than those of 1986, about the same number of farmers managed this agricultural type in both years, but the group consisted of different farmers in 1989.

In Yanallpa, in 1986, the playa cowpea fields was the most popular agricultural type managed as a second cash crops. The drop in number of farmers, from 58% to 35% ,who had a playa cowpea field in Yanallpa between 1986 and 1989 can largely be explained by the increase in farmers having plantain fields. In 1986, farmers faced reduced incomes since they could not sell any plantains that year. Although the net returns for cowpea are less than for other cash crops, there was no additional land available to grow rice or corn. Hence farmers chose to grow cowpea to compensate for the losses in income from plantain production as a result of the flood in 1986. In 1989 the plantain fields were restored, and many farmers gave up their playa cowpea fields. Furthermore vegetable production also increased, probably in response to a higher demand in Requena.

STRATEGIC FARMING IN THE FLOODPLAIN

According to Gladwin & Murtaugh (1980) studies of agricultural decision-making of small farmers should finally lead too the prediction of their future economic behavior. The previous discussion did not reach this goal. Although this may be unfortunate, because such an understanding would be useful, it teaches something very important about ribereño agriculture. In the previous analysis it was possible to demonstrate the complexity of ribereño farming, and the complex way in which ecological, economic, and social factors interact in the mechanisms leading to agricultural choices of ribereño farmers. Much work still remains to be done before a sufficient understanding of ribereño resource management can be achieved. This understanding is necessary if any well-founded extension or development action is to be carried out in the floodplain.

The previous discussion probably, more than anything else, has shown that ribereño agriculture is very individualistic. The diversity and variation which has been discussed above indicate that there are many ways to make a living for ribereño farmers. They also indicate that ribereños have many possibilities for resource management which probably have not yet even been explored. Complexity of ribereño resource management does not completely defy systematization. Stratification of groups of farmers as found in Santa Rosa and Yanallpa is not self evident, and it is difficult to sort out how single factors influence ribereño agricultural decision making. Characteristics used for stratification in other studies like size of holdings (Barlett 1977), or number of farming unit members (Chayanov 1986; Chibnik 1980), only partly explain ribereño agricultural strategies. Rather than focussing on single factors, interaction among several factors should be used to explain specific strategies.

The individualistic approach of ribereño farmers can be explained as a response to the ecological complexity of agricultural sites and the dynamics of the floodplain. The various agricultural options in this environment, which are a result of the variation in appropriateness of land for agriculture purposes, involve a total different amount of labor, scheduling of activities, risk and returns. Therefore, farmers very carefully choose the strategies which best meet their specific possibilities and needs. As argued before, access to certain types of land is an important factor which influences the direction of agricultural strategies adopted by individual farmers. The amount of labor farmers have available also significantly influences how agricultural enterprises are expanded. Decisions on new agricultural activities are also influenced by which agricultural activities are already taking place.

Given the complexity of the environment, agricultural decisions are very site specific. This requires detailed monitoring of agricultural fields. Single agricultural fields mostly cover a limited area, so that their ecological conditions are rather uniform, and they can be planted to a single crop or crop combination. Monitoring of such agricultural fields and making agricultural decisions indeed is best carried out by single farmers. Independent farmers are more capable of doing both than any other organized group. Both individual farming and variable agricultural strategies are therefore adaptations to the dynamic floodplain environment.

The agricultural diversity and variation in agricultural strategies found among ribereños has consequences for research methodologies. Individual cases never give an adequate picture of the whole group (Padoch & de Jong 1987). Furthermore, a study of a single community, common in most ethnographic or peasant studies, is not a sufficiently large enough sample for larger groups like the whole ribereño population of Peru. General agricultural strategies in Santa Rosa and Yanallpa are sufficiently different from each other to justify, and even demand, research in at least two villages. Although, as was argued in chapter two, the two communities represent two village types from the Peruvian Amazon, it is also clear that numerous variables vary considerably in other places, e.g. market opportunities, local history, or specific ecological conditions. The two cases discussed above therefore cannot be considered representative for the whole Peruvian Amazon, and elsewhere ribereño resource management is most likely different.

According to Hiraoka (1985b) increased involvement with regional and national economies, especially through greater possibilities for marketing agricultural and forest products, has significantly changed ribereño livelihood since the 1950s. Indeed, in most villages few people still accept the isolated lifestyle of several decades ago. Improved schooling, increased material goods, and leisure trips to Iquitos have become normal for many ribereños. On the other hand, ribereños have no choice but to share in the economic malaise which Peru has endured for several years. Although the long term changes which Hiraoka (1985b) reported may not have become evident from the data presented above, it is most likely that some tendencies observed are linked to such larger trends and will continue for longer periods.

The economic policy towards a free-market economy, which the Peruvian government now advocates, has resulted in the abolishment of a guaranteed price for rice. Most likely this will decrease the importance of rice as a cash crop, a trend which was already evident in the two villages in 1991. However, the preceding discussion has sufficiently demonstrated that ribereño farmers are accustomed to changes. This means that they will continue to adapt to new circumstances by modifying their agricultural practices. These modifications will be long-term changes, hidden below the short-term and visible variation in agricultural practices as described in the present chapter.

CHAPTER SIX

FOREST GARDENING IN SANTA ROSA

(A slightly revised version of this chapter has been accepted for publication in Agroforestry Systems)

INTRODUCTION

Nearly two decades have passed since agroforestry became an established scientific sub-discipline among the agricultural sciences (Nair 1990; King 1989). Although agroforestry was initially hailed as a land use option which could bring sustainable development to regions where other agricultural methods had failed (Nair 1990), it has not yet fulfilled this expectation. Examples of successful implementation of new agroforestry practices remain few (e.g. Buck 1990; Scherr 1990; Bishop 1983; Boonkird et al. 1984; Bourke 1985; MacDicken 1990; Getahun 1990). Much hope today is founded on developing indigenous agroforestry, and calls are made for continued and profound research on these practices (Budd et al. 1990; MacDicken 1990; Rocheleau 1987; Nair 1990). Many scientists and development workers advocate that designing improved systems should be based on existing agroforestry practices and make use of people's knowledge and experience (Beer et al. 1990; Lageman & Heuveldorp 1983; Duchhart et al. 1990; Buck 1990; Scherr 1990). Some scientists expect that important advances in agroforestry in the next 10 to 20 years may come from development experiences, rather than from research (Beer et al. 1990). However, we still understand too little about how indigenous agroforestry systems function (Nair 1990). According to MacDicken & Vergara (1990: 1), "the science of agroforestry lags far behind the art of existing agroforestry practices".

Shifting cultivation, or swidden agriculture, in which crops and trees are deliberately combined, are among the oldest and most widespread forms of agroforestry (Raintree & Warner 1986; MacDicken 1990; Gholz 1987; Vergara

1987). Many scientists suggest that shifting cultivation practices should be improved applying agroforestry technologies (Raintree and Warner 1986; Rao et al. 1991; Allen 1985; Wiersum 1983; 1985; Andriesse 1978). In most cases, however, little attention has been paid to the existing agroforestry component of traditional swidden agriculture (e.g. Raintree & Warner 1986; Dubois 1990).

Padoch en de Jong (1987) showed that swidden-fallow agroforestry within a single region may vary as the result of factors like market access and other agricultural activities of farmers. In this chapter the diversity of swidden-fallow agroforestry in a single village, Santa Rosa is discussed. In chapter four it was explained why forest gardens in Santa Rosa are to be considered as a separate agricultural type. Cultivation measures include planting, weeding, and harvesting. The amount and frequencies of these activities often vary between fields, resulting in a variation of forest gardens differing in species composition, structure and amount of produce which can be harvested. This discussion also demonstrates that a single agricultural type may show considerable variation, and further emphasizes the complexity of ribereño agriculture.

SWIDDEN-FALLOW AGROFORESTRY

Manipulation of woody secondary vegetation of older swiddens was reported in early works on natural resource management of traditional swidden farmers (e.g. Conklin 1957; Spencer 1966; Clarke 1971; Denevan 1971; Harris 1971; Gordon 1969, 1982). Research carried out largely in the last decade has shown that indeed many forms of shifting cultivation include active management of economically important tree crops in the fallow vegetation. Denevan and Padoch (1987) suggested that the term swidden-fallow agroforestry should be used to describe these practices.

Ribereño swidden-fallow agroforestry differs in the resulting vegetation of the forest gardens, the amount of labor they receive, and the destination of the produce. While some of the agroforestry systems developed by ribereño farmers are principally market-oriented (Padoch et al. 1985; Hiraoka 1986), they also provide a mix of products used in daily subsistence (Denevan & Padoch 1987; Padoch & de Jong 1987, 1989). Market opportunities, individual needs, and other productive activities of farmers are the most important socioeconomic factors which influence the variation in agroforestry practices (Padoch & de Jong 1987). Since these factors are different in almost every locality in the Peruvian Amazon, no single and unique ribereño agroforestry practice exists. Rather, there are a large variation of practices, which differ in degrees from each other.

Swidden-fallow agroforestry, as practiced by most Amazonian farmers, is characterized by a change in the management pattern of a swidden after several years of farming. Farmers do not continue the intensive use of a field for more than two to four years because decreasing returns and increasing weed invasion make it less profitable than changing the field to a forest garden and making a new swidden elsewhere (Denevan 1971; Ewel 1986; Hoekstra 1987). Older fields continue to be economically important, and are not simply abandoned. Products may be harvested from planted or naturally occurring species. Besides harvesting, weeding and planting continue to be carried out in older fields (Denevan & Padoch 1987; Denevan et al. 1984; Irvine 1987).

The change in the management pattern from a terra firme swidden, be it a plantain field, or chacra, to a forest garden is anticipated by most ribereños long before it actually happens. While the field is still a chacra or plantain field, farmers plant several tree species which will yield products to be harvested after conversion into a forest garden. Nonetheless, how the forest garden finally will be managed may be influenced by several other factors, some of which are not at all related to what trees were planted in the field. The structure of a forest garden varies not only from field to field, but also from year to year (Alcorn 1990: 143). Such structure changes were shown in chapter five to be related to changes in the agricultural strategies of individual farmers.

Once the principal crops of a swidden cease to be harvested, the subsequent frequency and thoroughness of weeding also differs between fields. The area around planted or tended trees is cleared infrequently. Sometimes tree crops receive no attention at all for several years when they start yielding fruits. Once several fruit trees start to produce, fields often are slash-weeded again either partially or completely. It is also not uncommon for farmers continue to slash-weed terra firme fields once or twice a year during the transition period to a forest garden.

In order to assess diversity in swidden-fallow agroforestry in Santa Rosa, seven fields were surveyed. The composition of managed species, production levels, and weeding patterns of each of these fields are compared below. First a general description of the seven forest gardens will be provided, including field location, vegetation, and the land-use history as recorded from the current owners. Subsequently the composition of managed plant species will be compared between fields. Finally the intensity and frequency of weeding, and the yield levels are discussed.

SANTA ROSA FOREST GARDENS

Boerboom (1974) has pointed out the problems that occur with the study of secondary succession of tropical forests. It is almost impossible to find a number of plots of secondary forests for which only a very specific set of factors vary, so that only the influence of those factors on the forest development can be evaluated. More recently Van Rompay (1993) stated that homogeneous plots do not exist in tropical forests and therefore neither repetition of experiments, nor repetition of observations of the same forest are possible.

Similar problems occurred during the study of the management of Santa Rosa forest gardens. Instead of attempting an homogenous selection, fields were surveyed which represented as broad a variation of forest gardens as could be found. Fields therefore differ not only in the way they were managed, but also in their age, and land-use history. This makes it more difficult to draw conclusions from the findings, since there are many factors which can explain the variation. However, being a first assessment of diversity in ribereño agroforestry in a single community it was necessary to describe the large variation first rather than attempting to standardize the sampling as much as possible. The following provides a description of each field.

Forest garden A was two years and 10 months old when it was surveyed. At the time of the surveys, fruit species and tended forest species were evenly distributed throughout the field. Originally the field was planted as a chacra, and the crops grown included manioc, plantains, sugarcane, peppers, and pineapple. Many fruit species had been planted at an early stage, but other species like palm heart *(Euterpe precatoria)*, and tropical cedar *(Cedrela odorata)*, had been planted only when the field was two years old. When the field was surveyed, it was being weeded for the third time, and for the first time since the last manioc had been harvested.

Forest garden B was between 20 and 25 years old, according to the son of the original farmer. It had a closed high tree vegetation. The original field had been slashed in primary forest, planted as a chacra, and managed as an orchard ever since. Most of the area of this forest garden was slash-weeded about twice per year, but different locations in different periods.

Forest garden C was between 30 and 35 years old. The field is uniquely positioned at the foot of the hillock on which Santa Rosa is located, forming part of the village center itself. The main village street leads through this mixed orchard, and the house of the owner is located inside the field. The field was made as a swidden in the early sixties when the original founders of Santa Rosa returned from their travels from the Napo river (Padoch & de Jong 1990 and chapter three). Just like forest garden B, most of this field is kept clean of unwanted vegetation by irregular, but almost continuous weeding.

Forest garden D was seven years old. The field had a well developed tree vegetation but it wasn't as high nor were the diameters as large as those in forest gardens B and C. It was originally cut from a primary forest area, and planted as a chacra with manioc, plantains and fruit trees. The current weeding intensity was much lower than that of forest gardens A, B, and C. Patches of the field had recently been slash-weeded, but others were covered with high secondary forest.

Forest garden E was estimated to be about ten years old. The vegetation was similar to the one in forest garden C. The man who made the field had died, and only a small part of it was used by a different farmer. Shortly after surveying this field it was largely cut and a house was built on the site. This field had a similar spatial variation in weeded and non-weeded areas as forest garden D.

Forest garden F was seven years old. It had a closed secondary tree vegetation with only a few species of planted trees. The field had been made in two previous forest gardens, while the original natural forest vegetation has been slashed 13 and 14 years ago. This field, therefore, had been farmed as a chacra twice. Very little slash-weeding appeared to have taken place in this field.

Forest garden G was six years old. It was also covered with a dense secondary tree vegetation, with very few planted tree crops. The field had originally been made in a primary forest and had been managed as a chacra for two years. Forest garden G was slashed again and converted into a chacra shortly after it was surveyed. It appeared not to have received any significant recent slash-weeding.

RESULTS

Diversity of managed species

A total of 92 managed species (see chapter two for definition) were present in the seven terra firme forest gardens (Table 6.1). The number of managed plant species per single forest garden ranged from 14 to 48. Of the 92 managed species, only 47 were domesticated plant species, common in many Amazonian agricultural systems (Hiraoka 1986; Denevan & Padoch 1987; Calzada Benza 1980; Cavalcante 1976, 1978, 1980). The other 45 species were native species from the forest which were planted in these fields, or occurred spontaneously and were tended. In some cases trees of the original forest cover were spared while slashing the field. Such managing of native forest species is common in many agroforestry systems (e.g. Okafor & Fernandes 1987; Leuschner & Khaleque 1987; Fernandes et al. 1984; Michon et al. 1986; Anderson et al. 1985; Posey 1985; Rocheleau 1987).

Only seven species were present in all the seven forest gardens (Table 6.1), all cultivated fruit trees. They were *Rollinia* sp., *Pouteria caimito*, *Inga edulis*,

Table 6.1: Densities of managed plant species in seven forest gardens, Santa Rosa (Tot= Total, Rk = Rank)

Binomial, collection reference, and vernicular name	Forest garden								
	A	B	C	D	F	G	H	Tot	Rk
Alchornea triplinervia (de Jong 125, zancudo caspi)	42	0	0	0	0	0	0	42	25
Anacardium occidentale L. (casho)	0	4	8	0	10	0	0	22	37
Ananas comosus L. (piña)	683	7	0	33	1248	6	0	1977	1
Annona muricata L. (guanabana)	0	0	3	0	0	0	0	3	78
Annona sp. (de Jong 164, anonilla)	0	0	13	0	0	0	0	13	51
ANNONACEAE (de Jong 138, sacha anona)	4	0	0	3	0	0	0	7	63
ARECACEAE (inayuga)	8	0	0	0	5	0	0	13	49
Artocarpus incisa L. (de Jong 57, pandisho)	0	15	0	0	14	3	0	32	28
Astrocaryum chambira Burret. (chambira)	0	0	0	0	5	0	0	5	68
Astrocaryum huicungo Damm. (huicungo)	0	0	3	13	5	0	0	21	39
Bactris gasipaes (pijuayo)	92	122	27	50	157	3	95	546	4
Bixa sp. (de Jong 144, sacha achiote)	4	0	3	0	0	0	0	7	63
Calathea allouia (Aubl.) Lindl. (daledale)	0	48	0	0	0	0	10	58	20
C. sp. (de Jong 142, uchpa vijau)	8	0	0	127	0	3	0	138	11
C. sp. (de Jong 145, huira vijau)	0	0	0	0	14	0	0	14	47
Calycophyllum spruceanum (Benth.) Hook. (de Jong 35, capirona)	8	0	0	3	0	0	0	11	54
Capsicum spp. (de Jong, 53,55,56,62,71, aji)	4	0	0	0	0	0	0	4	73
Carica papaya L. (papaya)	17	4	0	7	0	0	5	33	27
Cecropia membranacea Tréc. (de Jong 163, cetico)	4	0	0	0	0	0	0	4	73
Cedrela odorata (de Jong 26, cedro)	0	70	11	0	43	0	5	129	12
Citrus aurantifolia (Chisten) Swingle (de Jong 72, limon dulce)	0	26	45	0	0	0	0	71	17
C. limon (L.) Burm (de Jong 154, limon)	0	15	11	0	24	0	0	50	21
C. nobilis var. *deliciosa* Swingle (de Jong 153, mandarina)	0	4	21	0	0	0	0	25	36

Table 6.1 continued

Species name, collection reference, and vernicular name	Forest garden A	B	C	D	F	G	H	Tot	Rk
C. paradisi Macfaden (de Jong 152, toronja)	0	11	24	0	0	3	0	38	26
C. sinensis (L.) Osla (de Jong 76, naranja)	83	44	96	7	0	6	10	246	8
Citrus sp. (de Jong 75, pomelo)	0	0	13	0	0	0	0	13	49
Coffea arabica L. (cafe)	0	33	13	0	0	24	0	70	18
Colocasia esculenta (L.)Schott (de Jong 68, huitina)	8	0	3	0	0	0	0	11	54
Couma macrocarpa Barb.Rodr. (Peters 111, leche caspi)	0	7	5	10	0	0	5	27	34
Crescentia cujete L. (de Jong 52, huingo)	0	4	8	0	0	0	0	12	53
Curcuma longa L. (de Jong 11, guisador)	12	4	0	0	0	0	0	16	44
Dioscorea trifida L. (sacha papa)	25	0	0	7	24	3	0	59	19
Eugenia stipitata McVaugh (de Jong 151, araza)	0	0	0	7	0	0	0	7	63
Euterpe precatoria (husai)	0	7	5	0	5	0	0	17	42
Ficus sp. (de Jong 141, oje)	12	0	3	0	0	0	0	15	46
Ficus sp. (de Jong 89, renaco)	0	0	0	0	10	0	0	10	57
Genipa americana L. (de Jong 134, huito)	0	0	8	0	0	0	0	8	59
Grias peruviana Miers (de Jong 50, sacha mango)	4	26	8	0	5	0	0	43	24
Himatanthus cf. *sucuuba* (Spruce) Woods. (Peters 166, bellaco caspi)	0	4	0	3	10	0	0	17	42
Hura crepitans L. (de Jong 149, katawa)	0	0	3	0	0	0	0	3	78
Inga densiflora (Benth., de Jong 128a, vacapaca)	0	0	5	0	0	0	0	5	68
I. edulis Mart. (guava)	46	7	67	93	71	130	38	452	5
I. macrophylla H.& B. ex Willd. (de Jong 133, guava peluda)	0	11	0	0	0	0	10	21	39
I. pilosula (Rich.) Macbr. (de Jong 81, shimbillo)	12	0	11	3	5	0	0	31	30
Jacaranda copaia Aubl. (huamansamana)	4	0	0	0	0	0	0	4	73
Jessenia bataua (Mart.) Burret (ungurahui)	0	7	0	0	19	0	0	26	35
Lonchocarpus nicou (Aubl.) DC. (barbasco)	33	7	0	0	0	3	33	76	16

Table 6.1 continued

Species name, collection reference, and vernicular name	A	B	C	D	F	G	H	Tot	Rk
				Forest garden					
Mangifera indica L. (mango)	8	18	3	0	0	3	0	32	28
Mauritia flexuosa L. (aguaje)	0	0	29	0	0	0	0	29	32
Miconia pilgeriana Ule (de Jong 129, rifari)	29	0	0	0	0	0	0	29	32
Miconia sp. (de Jong 165, rifari blanco)	192	0	0	0	0	0	0	192	9
Musa paradisiaca L. (platano)	471	15	3	177	33	103	324	1126	2
Ochroma lagopus Swartz (topa)	8	0	0	0	0	0	0	8	59
Oenocarpus mapora Karst. (de Jong 7, sinamillo)	0	0	16	0	14	0	0	30	31
Palicourea duroia (de Jong 162, palta moena)	0	0	0	0	5	0	0	5	68
Paspalum repens Berg. (de Jong 130, cariso)	0	0	13	0	0	0	0	13	51
Persea americana Mill. (palta)	4	0	3	3	0	0	0	10	57
Petiveria alliacea L. (de Jong 16, mucura)	0	0	3	0	0	0	0	3	78
Phytolephas macrocarpa R.& P (yarina)	0	15	3	0	0	0	0	18	41
Poraqueiba sericea Tul. (de Jong 41, umari)	8	100	32	23	5	15	86	269	7
Pourouma cecropiifolia Mar. ex Miq. (uvilla)	50	26	27	70	81	61	19	334	6
Pouteria caimito (R&P) Radlk. (caimito)	25	204	61	97	167	82	5	641	3
Psidium guayava L. (guayaba)	21	22	24	20	29	12	0	128	13
Quararibea cordata (H.& B.) Vischer (zapote)	0	22	0	0	0	0	0	22	37
Rheedia sp. (de Jong 78, charichuelo)	0	4	5	0	5	0	0	14	47
Rollinia mucosa (Jacq.) Baill. (de Jong 48, anona)	25	26	13	10	24	48	33	179	10
Saccharum officinarum L. (caña)	83	0	3	7	0	6	0	99	14
Scheelea brachyclada Burret (Ruiz 1424, shapaja)	0	0	5	3	0	0	0	8	59
Senna multijuga (Rich.) I.& B. (Ruiz 1464, pashaco)	4	0	0	0	0	0	0	4	73
Socratea exorrhiza (Mart.) Wendl. (de Jong 49, casha pona)	0	11	5	0	0	0	0	16	44
Solanum stramonifolium Jacq. (de Jong 64, coconilla)	4	0	3	0	0	0	0	7	63
Spondias dulcis L. (taperiba)	0	0	0	3	0	0	0	3	78

Table 6.1 continued

Species name, collection reference, and vernicular name	A	B	C	D	F	G	H	Tot	Rk
				Forest garden					
Spondias mombin L. (uvos)	0	0	5	0	0	0	0	5	68
Syzygium malaccensis (L.) Merr.& Perry (mamey)	0	26	19	0	0	3	0	48	23
Tabebuia crysantha (Jacq.) Nicholson (de Jong 166, tahuari)	8	0	0	0	0	0	0	8	59
Theobroma bicolor Humb.& Bonpl. (macambo)	4	22	21	3	0	0	0	50	21
Theobroma obovatum Klotzsch ex Bernoulli (de Jong 156, cacahuillo)	0	4	3	0	0	0	0	7	63
Vernonia patens HBK (de Jong 131, ocuera negra)	4	0	0	0	0	0	0	4	73
Vismia angusta Miq. (de Jong 132, pichirina)	92	0	0	0	0	0	0	92	15
Vitex sp. (de Jong 137, almendra)	4	7	0	0	0	0	0	11	54
? (de Jong 42, sushana caspi)	0	0	0	3	0	0	0	0	78
? (zapo huasca)	0	0	0	0	5	0	0	5	68
? (sacha ajos)	0	0	3	0	0	0	0	3	78
Total individuals	2157	1009	719	785	2042	517	678		
Total species	40	38	48	26	28	19	14		

Bactris gasipaes, *Musa paradisiaca*, *Poraqueiba sericea*, and *Pourouma cecropifolia*. A total of 63 species occurred in only three or less forest gardens, with 28 of those species occurring in only one of the fields sampled. *Miconia pilgeriana* the species which ranked number nine in total number of plant individuals, was tended in only one forest garden (garden A). This species is a secondary forest tree which is used for construction purposes. Other forest species ranking high in total number of plant individuals were *Cedrela odorata* grown for its timber, *Vismia angusta* grown to be used as round wood in construction, and *Calathea* sp. grown for its leaves used for wrapping. The case of the *Calathea* sp. is especially interesting since its natural habitat is restricted to the floodplain. It had been introduced on terra firme by the owner of forest garden D, where it reproduced easily and became very abundant. Forest garden D is now a source of this *Calathea* sp. leaves for many people in Santa Rosa.

Weeding patterns

The weeding patterns of four forest gardens (A, B, D, and F) were compared by estimating the state of the non managed vegetation (weeds) every three months for a total of 18 months, in the same transects in which densities of managed species were measured. No permanent plots were established in forest garden C because of its location close to the village, nor in forest garden E and G because they were slashed soon after the first survey. The use of the Index of Non-Managed Vegetation (I_{nmv}) is explained in chapter two.

Forest garden A showed a regular weeding pattern relatively uniform throughout the whole field (Figure 6.1). During the first observation, the field was in the process of being slash-weeded, and the larger part (83%) had only heel-high weeds (I_{nmv} 1). A smaller part (17%) was covered with taller knee-high weeds (I_{nmv} 2). During the second observation this slash-weeding was finished and the whole field had a cover of only heel high weed vegetation (Figure 6.1). During observations three, four, and five the field showed a gradual increase of areas with waist-high weed vegetation (I_{nmv} 3). But between the fifth and sixth observation the field was slash-weeded completely again, resulting in a total cover of knee high weed vegetation (I_{nmv} 2) during observation six.

The weeding pattern in forest garden B was much more irregular than in the previous field. During the first observation, two thirds of the field (67%) had a only a heel-high weed cover (I_{nmv} 1). In the other third of the field (33%) the weed vegetation was knee- and waist-high (I_{nmv} 2 and 3). This latter area of forest garden B apparently received much less attention from the owner (Figure 6.1). Weed vegetation increased in forest garden B through the second and third observations resulting in waist to person-high weeds (I_{nmv} 3 and 4). However, by the fourth observation this tendency was partly reversed, and the area with knee-high weeds (I_{nmv} 2) increased again. During the third and fourth observation 22% of the field was covered by a person-high vegetation (I_{nmv} 4).

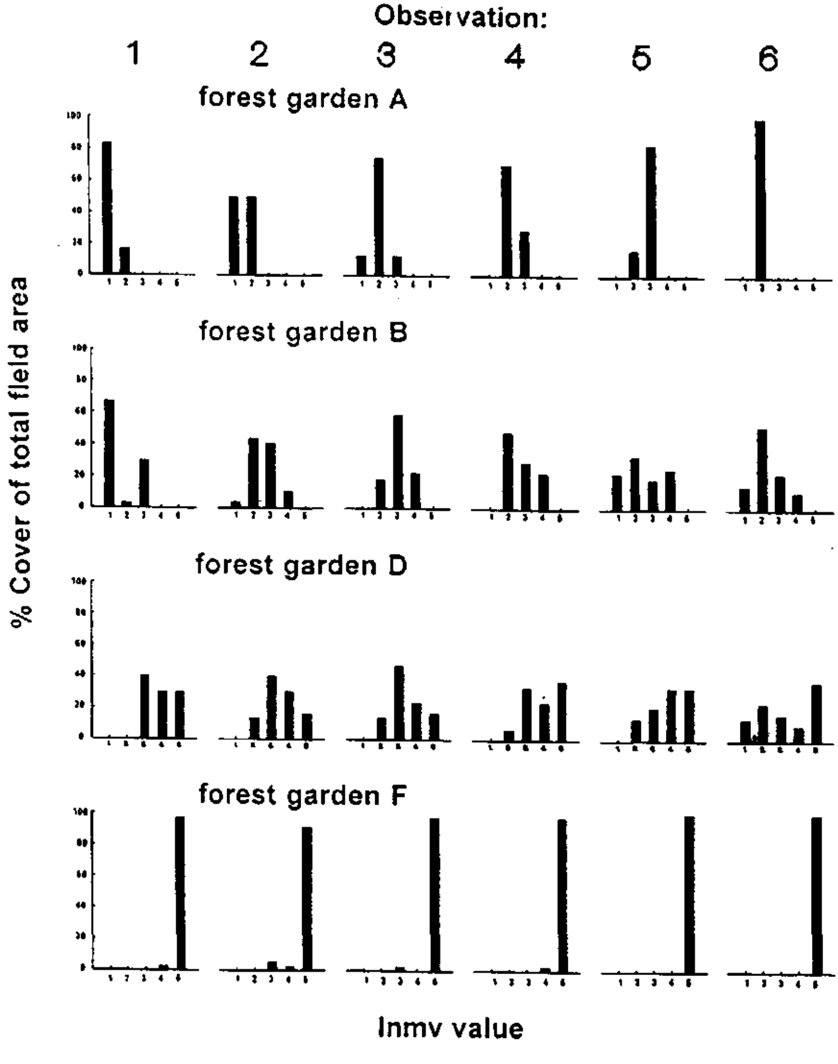

Figure 6.1 Non-managed vegetation Index (I_{nmv}) in four forest gardens. Each single graph indicates the percentage of the total area of a single field covered with weed vegetation represented by a certain I_{nmv} value at a single observation. Observations were repeated six times at quarterly intervals. I_{nmv} values: 1 = heel high; 2 = knee high; 3 = waist high; 4 = person high; 5 = area covered with secondary forest.

Between observation four and five, parts of forest garden B which had knee and person high weeds (I_{nmv} 2 and 3) were slash-weeded again, while other areas with person high vegetation were left untouched. At the last observation, however, the area with person high weed vegetation (I_{nmv} 4) decreased, and a larger area showed only knee high weeds (I_{nmv} 2). In the period between the last two observations the area which had gone without weeding for the longest period was cleared, while those areas cleared in the previous period were left undisturbed.

At the first observation, forest garden D showed a large area (60%) covered with person and forest high weed vegetation (I_{nmv} 4 or 5, Figure 6.1). During all six observations the area covered by such a high weed vegetation was never less than 47% of the field. However, the other half of the field was slash-weeded following a regular schedule, similar to that of field A. Between the first and second observation, a smaller area was slash-weeded, resulting in a slight increase in the part with knee high weeds (I_{nmv} 2). The next two observations showed an increase of areas with a taller weeds, but during the fifth and especially during the sixth observation the area with lower weeds increased again as a result of a slash-weeding of these areas.

In forest garden F much less weeding was carried out than in any of the previous fields during the 18 months of observation. During the second and third observations a smaller area did have a waist high weed vegetation (I_{nmv} 3, Figure 6.1). The rest of the field had waist and person high weeds throughout the 18 months. At observations five and six, 100% of the field had a forest high weed vegetation (I_{nmv} 5).

Yield levels

Yield levels of economically important products in the same four forest gardens were estimated using methods described in chapter two. A total number of 42 different plant species, or 67% of all the managed species found in the four gardens yielded harvestable products. In forest garden A the number of species yielding harvestable products was 24, or 60% of all the managed species in the field. In forest garden B this was 23, or 61% of the managed species. In forest

Table 6.2: Production per hectare of four forest gardens in Santa Rosa during a fifteen months period. Yield levels are in number of fruits unless otherwise indicated.

Binomial and spanish name	Forest garden			
	A	B	D	F
Ananas comosus, piña	1333	4	7	0
Artocaprus incisa, pandisho	0	85	0	0
Astrocaryum huicungo, huicungo (trees)	0	0	3	0
Bactris gasipaes, pijuayo (racemes)	100	400	120	0
Capsicum spp., aji	208	0	0	0
Carica papaya, papaya	242	0	27	0
Calathea alloiua, daledale	0	26	0	0
Calathea sp., huira vijau (plants)	4	0	0	0
Calathea sp., uchpa vijau (plants)	8	0	127	3
Cedrela odorata, cedro (stems)	0	7	0	0
Citrus auranthifolia, limon dulce	0	504	0	0
Citrus limon, limon	0	411	0	0
Citrus sinensis, naranja	0	2482	0	0
Coffea arabica, cafe	0	11	0	6
Colocasia esculenta, huitina	4	0	0	0
Couma macrocapra, leche caspi (trees)	0	7	0	10
Dioscorea trifida, sacha papa	8	0	27	21
Euterpe precatoria, huasai (racemes)	0	15	0	0
Grias peruviana, sacha mango	0	15	0	0
Inga edulis, guava	4162	0	6523	2394
I. macrophylla, guava peluda	0	44	0	0
Jacaranda copaia, huamansamana (stems)	4	0	0	0
Lonchocarpus nicou, barbasco (stems)	38	0	0	0
Miconia pilgeriana, rifari (stems)	29	0	0	0
Miconia sp., rifari blanco (stems)	192	0	0	0
Musa paradisiaca, platano (racemes)	329	26	160	91
Phytolephas macrocarpa, yarina (trees)	0	15	0	0
Poraqueiba sericeae, umari	0	5630	0	0
Pourouma cecropiifolia, uvilla	3558	482	757	0
Pouteria caimito, caimito	0	1518	337	333
Psidium guajava, guayaba	621	0	133	0
Quararibea cordata, zapote	0	2111	0	0
Rollinia mucosa, anona	288	37	0	0
Saccharum officinarum, caña (stems)	188	0	3	0
Senna multijuga, pashaco (stems)	4	0	0	0
Socratea exorrhiza, casha pona (stems)	0	11	0	0
Solanum sessiliflorum, cocona	25	0	0	0
Solanum stramonifolium, coconilla	171	0	0	0
Syzigium malaccensis, mamey	0	3926	0	0
Theobroma bicolor, macambo	0	70	20	0
Vernonia patens, ocuera negra (stems)	4	0	0	0
Vismia angusta, pichirina (stems)	92	0	0	0

garden D only 13, or 50% of the managed species produced harvestable products, and in forest garden F only seven, or 37% of the species yielded harvestable products. Other amounts of harvestable products per species are presented in Table 6.2.

It appears that not all the species which were planted actually yielded products for which they were planted. This is a direct result of the opportunistic approach which ribereño farmers follow in their resource management activities. Ribereños have to anticipate many different possible situations when making agricultural decisions. Farmers may intend to manage a forest garden in a certain way, but, in response to other factors, in the end decide not to follow the original plan. Hence, species may be planted, that in the end are not tended properly, and hence can not be harvested.

MANAGEMENT OF RIBEREÑO FOREST GARDENS.

According to Fresco (1986: 110) management and labor are the most important inputs of cropping systems among shifting cultivators. In many studies of agroforestry systems such management is reported to have different levels of intensity (e.g. Nair 1989), although it is seldom specified how such variable management intensity can be measured. In chapter two, management of an agricultural field was defined as purposely influencing the development of its vegetation. Cultivation practices that most influence the vegetation of a forest garden are planting and weeding. The densities and diversity of managed species, and weeding patterns, therefore, are the main indicators of different management patterns in the of Santa Rosa forest gardens.

The results presented above show four different weeding patterns of the fields studied. Forest garden A showed a regular pattern of one complete slash-weeding per year. However, as the field became older this slash-weeding became less thorough from year to year. The larger part of forest garden B was kept fairly clean, but other parts were only cleared when the weed vegetation began turning into dense secondary forest. The slash-weeding activities here were spread out over the whole year, but covered different areas at different times.

Forest garden A and B, and forest garden C which had weeding pattern similar to forest garden B, had similar numbers of managed species (respectively 40, 38, and 48, Table 6.1). The difference in weeding patterns is attributed to the difference in age of the two fields. Forest garden A, which was not yet three years old, when the survey began, required a more thorough weeding in order to achieve the desired composition and structure of the vegetation. In the older forest garden B, which had a well established forest vegetation, less effort was necessary to maintain the existing composition and structure. This is also reflected by the amount of labor input needed for weeding each field. The amount of labor recorded by the owner of forest garden A in a diary during one year was 13.5 work days. The owner of forest garden B recorded only 0.75 work days spent in the same activity (Padoch & de Jong 1989).

Forest garden D had a one year slash-weeding schedule, but only half of the field was cleared. This is consistent with the lower number of managed species in this field. Forest garden D, and forest garden E, in which the weeding pattern is similar, had 26 and 28 managed species. Only the areas where those managed species are present are kept under control, while in the other parts the vegetation had been allowed to develop freely. It is not impossible that the owner of forest garden D spent the same amount of labor on weeding as the owner of forest garden B. The slash-weeded area in forest garden D increased section by section during the observation period. This is a consequence of more trees reaching sizes at which they start yielding harvestable products, at which point their direct surroundings are than slash-weeded. Once the managed vegetation of forest garden D becomes fully grown, this field may well be managed in the same way as forest garden B. Such a strategy makes sense, since a more intensive management of the field would require higher labor inputs at younger stages than when the field is older.

The last forest garden F had very few managed species, and subsequently was virtually not cleared at all. It is unlikely that this will change since the current status of the non-managed vegetation and the low density of managed species do not justify such investment. The owner of this field stated that he will make a new field on the same site once the secondary forest is dense enough to suppress the grasses still present. This field and forest garden G are most closely related to the abandoned swidden, which is still to often considered typical of shifting cultivation practices. Forest garden F, however, retained a total of 19 managed species, and forest garden G had 14 managed species.

PATHWAYS FOR INTENSIFICATION OF RIBEREÑO AGROFORESTRY

According to Nair (1990) most of the existent agroforestry practices in the tropics need to be developed into modern agroforestry technologies through scientific improvement. Some suggestions for such improvements have been given by Raintree & Warner (1986) who propose integral taungya, enriched fallows, or tree crop alternatives to intensify shifting cultivation practices. Dubois (1990) suggests a sequence of swiddening, enriched forest fallows, and perennial crop plantations for Amazonian Brazil, while Nair (1990) presents cacao grown under widely spaced rubber trees, coconuts, and peach palms as an option to farmers for additional cash income and economic stability. It is useful to discuss briefly (1) whether or not such an improvement is necessary for terra firme agroforestry practices in Santa Rosa, (2) how such an improvement could be achieved, and (3) to what extent the diversity of existing agroforestry practices has to be taken in consideration for such an improvement.

Increased population pressure among upland farmers often has resulted in shortening of the fallow period of swidden-fallow systems (Boserup 1965; Ruthenberg 1980; Clarke 1966). However, other examples demonstrate that higher population densities can also lead to intensified management of home gardens or forest gardens (e.g. Fernandes et al. 1984; Leuschner & Khaleque 1987; Soemarwoto et al. 1985; Michon 1985; Michon et al. 1986; Wiersum 1983; Christanty et al. 1986). Such intensification are often responses to a shortage of forest resources, rather than land shortage. Agroforestry intensification can also result from new market opportunities, as demonstrated by examples from the

Amazon (Padoch et al. 1985; Hiraoka 1986) or elsewhere (e.g. Eder 1981).

In general, Santa Rosa farmers practice more intensive agroforestry than farmers like the Bora Indians who live in a remoter area of Peru (Denevan & Padoch 1987), or the Runa Indians of Ecuador (Irvine 1987; 1989). The inhabitants of Santa Rosa do not sell any significant amounts of products from agroforestry fields in the market, but use most of it for home consumption (Padoch & de Jong 1989). As such it can be concluded that agroforestry intensification in Santa Rosa is a result of increased pressure on forest resources, and also a result of a greater demand for family labor.

The increased pressure on forest resources is a result of the sedentary life style of the Santa Rosa inhabitants. The distance to high forest becomes greater every year, and the forest resource within close vicinity to the village are harvested faster than they regenerate. Since Santa Rosa farmers engage in commercial agriculture, they have to minimize their labor expended on subsistence work. Producing forest resources in agroforestry fields therefore, becomes an economically attractive option.

Although ribereños are definitely in need of additional cash income and would eagerly welcome economic stability, it will not be easy to propose new agroforestry technologies which can provide such benefits as suggested by Nair (1990). Cacao, rubber, and coconut are difficult to produce on terra firme terrain, while the market for peach palm is extremely limited. Timber species are slow-growing, although some farmers expressed interest in planting *Cedrela odorata* and *Cedrelinga cataneiformis*, to produce marketable timber.

The focus on subsistence production in Santa Rosa agroforestry also explains part of the diversity in agroforestry practices. Since no obvious increase of monetary income is to be gained from single crop intensification in agroforestry fields, farmers value the economic benefits from agroforestry fields in different ways. It becomes a question of personal preference which crops are to be produced in such fields and how much effort they are worth. Farmers who live in the village of Tamshiyacu focus mainly on *Poraqueiba sericea* production, because they can market this product in Iquitos. Because earning cash income is the main goal of agroforestry fields in Tamshiyacu (Padoch et al. 1985; Hiraoka 1986, de Jong 1984), agroforestry intensification is much more uniform in this village. Since such market stimuli are minimal in Santa Rosa, farmers make forest gardens in accordance with their personal circumstances and desires.

Only agroforestry practices that would generate cash income, can be expected to be adopted widely in Santa Rosa. Given the great agricultural diversity among these farmers, it is not at all evident that agroforestry is the most appropriate way to reach increase monetary returns. A different strategy to increase household well-being could be to increase production of forest resources for local use. There is a tendency among many farmers to replace forest products with products that can be bought in the market. Since cash incomes among ribereños fluctuate greatly from year to year, producing stable forest resources in agroforestry fields may become more attractive to farmers. Since household economic conditions vary within single villages, interest in such subsistence production would also vary. Therefore, diversity in individual agroforestry practices will persist even if agroforestry intensification as suggested by Nair (1990) Raintree and Warner (1986) and Dubois (1990) could be achieved.

CHAPTER SEVEN

FLOODPLAIN AGROFORESTRY IN YANALLPA

INTRODUCTION

Indigenous agriculture of the Amazon floodplain is still a new field of research. It is, therefore, no surprise that varzea agroforestry has been less described than other agricultural systems of this ecological zone. Agroforestry practices are less common in varzea-like environments than in uplands, because the former are much rarer than dry-land, and because periodically flooded land is more often used for intensive cropping of annuals or non-wood perennials (e.g. Hopkins 1987; Ruthenberg 1980). Likewise, farmers who live in flooded areas in countries like Bangladesh and India, locate forest gardens and homes on dry land rather than in lands that are periodically inundated (Leuschner & Khaleque 1987; Ali 1987; Nair and Sreedharan 1986).

Varzea agroforestry and forest management have been studied in the Amazon estuary near Belem (Anderson 1990; Anderson et al. 1985; Gely 1989). The lands on which this kind of agroforestry occurs, however, flood daily and cannot be used for any other type of cropping. Frechione et al. (1989) and Parker et al. (1983) mentioned the occurrence of floodplain agroforestry among inhabitants of the middle reaches of the Amazon. Hiraoka (1985b) described briefly how floodplain farmers in Peru transform restinga fields to forest gardens after several years of swiddening. In these forest gardens, planted fruit trees and spontaneously occurring useful species are harvested, but they receive little tending. Bergman (1974) reports on tree growing in plantain fields as well as in orchards in floodplains along the Ucayali river. In the floodplains of the Atrato river in the Colombian Chocó region, agro-silvicultural practices including the growing of tropical cedar, *Cedrela odorata*, are reported (Leguizamo 1983, cited in Dubois 1990).

A more thorough study on varzea agroforestry has been conducted in the close vicinity of Manaus (Bahri et al. 1991; Guillaumet et al. 1990; Bahri 1988). Bahri et al. (1991) distinguish four different types of forest gardens located on the higher levees of Careiro island. These levees are not inundated by an average high flood. The types of forest gardens are: (1) mixed rubber and cacao stands which were planted around the turn of the century and are still exploited, (2) similar old plantations but enriched with fruit trees, (3) mixed fruit orchards with no rubber trees, and (4) pure rubber stands with pasture underneath. In these gardens 35 tended species were found, including fruit trees, medicinal plants, and species which yield a mixture of other useful materials (Guillaumet et al. 1990). The close distance between Careiro island and the Manaus market allows some sale of the produce from those fields. According to the researchers of these varzea agroforestry systems, only economic and historical factors influence the variation in species composition and management of the forest gardens, since ecological site conditions are uniform.

In the present chapter diversity in varzea agroforestry practices in the village of Yanallpa will be discussed. It will be argued that varzea diversity in agroforestry is partly a result of ecological conditions as well as economic circumstances of farmers. In this aspect, Yanallpa varzea agroforestry differs from the systems described for Careiro island in Brazil. In chapter four it was argued that, in the varzea variation in site conditions is one of the principal factors which determines its agricultural use. In the previous chapter, however, it was demonstrated that differences in ecological site conditions do not play a primary role in the variation in species composition and management of terra firme forests gardens. Forest gardens in Yanallpa, however, are located on sites which vary in soil structure and fertility, and which experience different flooding regimes. Soil texture, fertility and the flooding regime co-determine which type of agroforestry system is possible on a particular site.

To begin the discussion of varzea agroforestry, the relation between agroforestry practices and other varzea agricultural types will be discussed first. This will explain why agroforestry is less common in Yanallpa than in Santa Rosa, as noted in chapter five, and convey some awareness of the nature of the diversity among agroforestry fields. Subsequently, the agroforestry fields studied will be described, and a brief land-use history included. The latter was recorded from interviews of current field owners. The composition of the managed vegetation and the general weeding pattern of the same fields will be compared before more general conclusions are drawn from these findings.

YANALLPA FLOODPLAIN AGROFORESTRY

Agroforestry fields in Yanallpa are located on several parts of the principal village levee, qualified as high restingas, and on lower restingas on the backslopes of the same levee. Some agroforestry fields are located on smaller levees at larger distances from the river. Fertility and water retention capacity increase because the soil texture becomes finer as we approach the lower restingas.

On the lower restingas, below a certain elevation, fields flood every year. Higher up on the levees, beside trees which resist waterlogging for longer periods, short cyclic crops such as manioc can be grown. On the higher parts of the levees, plantains can be grown continuously for 15 years or longer without any need of fallowing, if they do not flood in earlier years. This means that in Yanallpa many different agricultural land use options exist for land which is used for agroforestry.

On terra firme, the change from managing a field as a chacra or a plantain field to a forest garden is the result of the decrease of soil fertility and the increase of weed invasion which make it economically unattractive to continue annual cropping. Continuing a field as a forest garden is more profitable than total abandon of a field. In Yanallpa, however, farmers have to choose between using a field either for agroforestry or for something else. Since arable land is more limited in Yanallpa than in Santa Rosa, farmers less often decide to make an agroforestry field. This explains why fewer farmers in Yanallpa than in Santa Rosa have agroforestry fields.

The nine agroforestry fields studied in Yanallpa differed in site conditions, land-use history, dominant vegetation, and weeding patterns. They were located on both higher and lower parts of the principal village levee, and on another different levee away from the river (see Figure 3.2 chapter three). Two mixed orchards which were not very different in appearance from those studied in Santa Rosa were surveyed. Also one field with predominantly mixed tree vegetation, and one field dominated by both *Cedrela odorata*, and *Calycophyllum spruceanum* trees were selected. One agroforestry field marked the boundary between terrains belonging to two different farmers.

In addition to these agroforestry fields four fields in which farmers combined annual crops with tree production were inventoried. In two fields, farmers grew plantains and several tree species together. In two other fields the owner grew corn with *Cedrela odorata* trees. It should be emphasized here that these fields were classified as plantain fields, and restinga corn fields when conducting the agricultural type inventory among Yanallpa households. In this chapter their tree component is compared with the other agroforestry fields.

YANALLPA AGROFORESTRY FIELDS

One of the two **mixed orchards** which were studied in Yanallpa **(field A)** began as a manioc and plantain field in which the owner had planted a few *Citrus paradisi* and *Bactris gasipaes* trees. Until the early 1970s the owner of this field lived in a house located on a part of the levee in front of the actual mixed orchard. This part of the levee was eroded by the river and the house was relocated to its present site inside the orchard. Some trees which were located close to the water's edge already were lost as a result of erosion. This phenomenon is an important factor in the dynamics of varzea agroforestry fields in general (e.g. Bahri et al. 1991), but especially on the Ucayali. The Ucayali, like the Marañon, is a meandering river, as opposed to the Amazon which for its largest part is a braiding river (Goulding 1980; Sioli 1984, see chapter 3). The shifting river channel may result in loss of agroforestry land, and subsequently in loss of planted crops. As a result of sedimentation, land may also become located at greater distances from the river channel, and as a consequence fields may lose their importance as intensively managed agroforestry systems.

In the orchard several of the *Syzigium malaccensis*, and *Cedrela odorata* trees were planted between 1965 and 1970. Other trees like *Scheelea brachyclada* or *Couepia* sp. were planted more recently. The *Mauritia flexuosa* trees also date from before 1970, but they appeared spontaneously from seeds disposed by the owners. According to the owner, several tree species which he grew in this field are no longer present anymore. Species like orange, *Pouteria caimito*, *Quararibea cordata*, *Rollinia mucosa*, and *Persea americana* (avocado), were all destroyed by the high flood in 1970. This loss discouraged the owner from replanting any species vulnerable to flooding.

The second **mixed orchard (field B)** which was also located on the principal levee, had a spatial pattern which was different from field number one. Trees were clustered in separated locations inside the field. In one area *Citrus* species were grown nearly exclusively. Five smaller areas, at the boundary of the field, were used to grow manioc and plantains. In two areas a combination of spices, medicinals, ornamentals, and sugarcane were grown. The field belonged to an older woman who came to Yanallpa in 1937. Since then she started planting this area with the species still present today. Only the agroforestry areas of this field were inventoried.

The **mixed-tree agroforestry field (field C)**, also located on the principal higher levee, was slashed in secondary forest in 1970. The field was first planted to corn, then to manioc, and later to plantains. The *Cedrela odorata* and *Calycophyllum spruceanum* trees, which were most abundant in this field, all stemmed from natural generation. The owner also planted a number of *Scheelea brachyclada* trees, several of which had died, probably as a result of the sand deposited by several floods. Until three years before the inventory, the field was managed as a mixed chacra-agroforestry field. When manioc and plantain production decreased, the owner decided to stop growing these crops and continued tree production only. In the second half of 1987, however, shortly after finishing the inventory, much of the tree vegetation was slash-weeded. The field was planted again with plantains and manioc underneath an open tree cover of *Cedrela odorata*, *Calycophyllum spruceanum* and some fruit trees. Before the slash-weeding, the owner already had harvested about 75 *Calycophyllum spruceanum* trees from this field, which he had used to construct three different houses of his own. Some of the trees he had sold to the village to construct the school building. None of the *Cedrela odorata* trees were yet of a harvestable size.

The **mixed *Cedrela odorata*/*Calycophyllum spruceanum* agroforestry field (field D)** contained only tree and shrub vegetation, and very few plantains. This field was located on a low restinga behind the principal village levee (Figure 3.2). The soils of this site were of finer texture, and flooded every year. If not used as an agroforestry field, the site could be used to grow rice, corn, or vegetables. The site was first slashed in 1943, and corn, beans, and about 60 *Cedrela odorata* trees were planted. The field was managed for a few years as a corn field, but then continued as an agroforestry field. All woody vegetation except the 60 cedar trees appeared spontaneously.

A common agroforestry practice found among Yanallpa farmers is the use of a small strip of trees to separate lands belonging to different farmers. The **boundary-strip agroforestry field (field E)** was not planted by the farmer in whose terrain it was located, and he did not know who the original planter was. The vegetation of this agroforestry field consisted of several fruit trees of different sizes, with a dense ground cover of *Calathea sp.*, a perennial herb.

One of the **mixed plantain/agroforestry fields (field F)**, located on the principal high levee, was slashed for the first time in 1966. It was first planted to manioc, and later turned into a plantain field. While slashing the field, a number of *Cedrela odorata* trees were spared, four of which were harvested two years later. New trees appeared spontaneously. At the time of the field inventory, the broken crown cover of the tree vegetation had regrown so dense that its shade affected plantain production. The field had been a plantain agroforestry field ever since it was made.

The **second plantain/agroforestry field (field G)**, also located on the high restinga, was slashed in 1932. That same year the owner planted several *Cedrela odorata* trees, of which he already had harvested ten at the time of the inventory. Many of the other trees of the same species present in the field are of a harvestable size, but the owner preferred not to sell them yet, since he had no urgent need for the money. Timber trees in particular are often kept as a savings in case of emergency by farmers in Yanallpa (Padoch & de Jong 1987).

The two **corn/Cedrela odorata/agroforestry fields (fields H and I)** belonged to the same owner. Both fields were located on the principal Yanallpa levee, but in a much lower area than the village center. In 1985 the farmer grew a crop of rice followed by a crop of corn in both fields. The rice yield was very unsatisfactory, and in 1986 and in 1987 the owner grew two crops of corn. In 1989 the two fields were planted with plantains, a rather risky endeavor because of the relatively low elevation of these fields and hence the high risk of flooding.

Both fields have been used for annual cropping for several decades. They were made by the father of the current owner before she was born, and the *Cedrela odorata* trees have been present in these fields as long as she can remember. In 1989 the owner harvested 35 trees from one of the two fields, and used the money obtained to finance the schooling of two sons in Lima.

RESULTS

Diversity of managed species

Of the 78 species which were managed in the 9 varzea agroforestry fields only 35 are domesticated plant species, while the other 43 species are non-domesticated species which occur naturally in native forests. Although plantain ranked as the species with the highest number of plant individuals in the nine agroforestry fields, *Calycophyllum spruceanum* and *Cedrela odorata*, both native forest species, ranked number 2 and 3 (Table 7.1). For instance in the *Cedrela odorata/ Calycophyllum spruceanum* agroforestry field (field D) these species accounted for 61% of all the managed plant individuals. Some species from one of the mixed orchards (field A) are particularly interesting. *Mauritia flexuosa*, *Inga densiflora*, and *Oenocarpus mapora* are three forest species grown for their fruits. In the same field *Scheelea brachyclada* is grown, which provides leaves which are used for

Table 7.1 Densities of managed species in nine varzea agroforestry fields in Yanallpa (Tot = Total, Rk = Rank)

Binomial, collection number and vernicular name	A	B	C	D	E	F	G	H	I	Tot	Rk
	Agroforestry field										
Allamanda cathartica L. (de Jong 169,	0	3	0	0	0	0	0	0	0	3	67
Alocasia macrorrhiza (L.) Schott (de Jong 67, huitina blanca)	0	3	0	0	0	11	0	0	0	14	48
Anacardium occidentale L. (casho)	0	17	0	0	0	0	0	0	0	17	47
Artocarpus incisa L. (de Jong 57, pandisho)	12	0	33	0	67	0	0	0	0	112	15
Bactris gasipaes HBK. (pijuayo)	0	0	0	0	0	0	5	0	0	5	61
Bixa orellana L. (de Jong 66, achiote)	3	0	0	0	0	0	0	0	0	3	71
Calathea sp. (de Jong 142, uchpa vijau)	19	7	48	0	0	50	86	0	0	210	7
Calycophyllum spruceanum (Benth.) Hook. (de Jong 35, capirona)	19	2	210	930	0	6	0	0	0	1167	2
Canavalia ensiformis DC. (de Jong 183, nescafe)	0	0	0	0	0	22	0	0	0	22	41
Capsicum annuum L. (de Jong 55, aji dulce)	0	12	0	0	0	0	0	0	0	12	50
C. spp. (de Jong 53,71,56,62, aji)	47	0	0	0	0	0	0	0	0	47	28
Carica papaya L. (papaya)	41	8	0	0	0	33	19	14	2	117	14
Casearia sp. (de Jong 27, limon casho)	0	0	0	60	0	0	0	0	0	60	23
Cecropia membranacea Tréc. (de Jong 163, cetico)	0	0	276	110	13	0	0	0	0	399	5
Cedrela odorata (cedro)	110	0	124	640	0	89	52	42	12	1069	3
Cedrelinga cataneiformis (tornillo) limon dulce)	0	1	0	0	0	0	0	0	0	1	72
Citrus aurantifolia (Chisten) Swingle (de Jong 72,	0	3	5	0	13	11	0	0	0	32	35
C. limon (L.) Burm (de Jong 154, limon)	9	2	0	0	0	0	0	0	0	11	53
C. nobilis var. deliciosa Swingle (tangarina)	0	0	0	20	27	0	0	0	0	47	28
C. paradisi Macfaden (de Jong 152, toronja)	91	60	100	0	0	0	5	0	0	256	6

Table 7.1, continued

Binomial, collection number and vernicular name	A	B	C	D	E	F	G	H	I	Tot	Rk
Coccoloba densifrons Mart. (de Jong 94, vino huayo)	0	0	0	0	13	0	0	0	0	13	49
Colocasia esculenta (L.) Schott (de Jong 68, huitina)	12	0	0	0	0	0	0	0	0	12	50
Couepia sp. (parinari)	3	2	0	0	13	0	0	0	0	18	46
Crescentia cujete L. (de Jong 52, huingo)	12	3	5	0	0	6	0	0	0	26	39
Cymbopogon citratus (DC.) Stapf. (de Jong 105, hierba luisa)	0	1	0	0	0	0	0	0	0	1	72
Dahlia sp. (de Jong 168, dalia)	0	1	0	0	0	0	0	0	0	1	72
Ficus sp. (de Jong 141, oje)	0	0	10	40	0	6	0	0	0	56	24
FLACOURTIACEAE (timareo)	6	0	0	70	0	0	0	0	0	76	17
Genipa americana L. (de Jong 134, huito)	12	9	5	0	27	11	10	1	0	75	18
Gossypium barbadense L. (de Jong 65, algodon)	3	2	0	0	0	0	0	0	0	5	61
Grias peruviana Miers (de Jong 50, sacha mango)	0	0	10	0	40	0	0	0	0	50	25
Guarea macrophylla Vahl (de Jong 177, requia)	0	0	0	140	0	6	0	0	0	146	11
Hevea sp. (de Jong 69, shirinaga)	6	1	5	50	67	0	0	0	0	129	12
Inga densiflora (Benth., de Jong 128a, vacapaca)	12	1	10	0	13	6	0	0	0	42	32
I. edulis Mart. (guava)	38	33	43	30	0	0	24	0	0	168	10
I. perizifera Benth. (de Jong 25, rujino shimbillo)	0	6	14	0	13	0	0	0	0	33	34
I. pilosula (Rich.) Macbr. (de Jong 81, shimbillo)	0	2	0	20	13	0	0	0	0	35	33
Inga. sp. (de Jong 173, guavilla)	3	0	0	0	67	0	0	0	0	70	20
Ipomoea batatas (L.) Lam. (de Jong 54, camote)	3	0	0	0	0	28	0	0	0	31	36

Agroforestry field: columns A–I.

Table 7.1, continued

Binomial, collection number and vernicular name	Agroforestry field A	B	C	D	E	F	G	H	I	Tot	Rk
I. quamoclit L. (de Jong 4, enredadera)	0	1	0	0	0	0	0	0	0	1	72
Jatropha curcas L. (de Jong 86, piñon blanco)	6	0	0	0	0	0	0	0	0	6	60
LAURACEAE (moena)	0	0	0	10	0	0	0	0	0	10	55
Mangifera indica L. (mango)	6	5	24	0	0	0	10	0	0	45	31
Manihot esculenta Crantz (yuca)	82	0	0	0	0	333	0	0	0	415	4
Mansoa alliacea (Lam.) A. Gentry (de Jong 146, ajo sacha)	3	0	0	0	0	0	5	0	0	8	59
Margaritaria nobilis L.F. (de Jong 24, loro micuno)	0	1	0	100	0	6	0	0	0	107	16
Mauritia flexuosa L. (aguaje)	22	4	5	10	13	0	14	0	0	68	22
Muntingia calabura L. (de Jong 176, yumanasa)	0	0	52	0	0	128	5	0	0	185	9
Musa paradisiaca L. (platano)	269	0	110	10	0	533	276	71	1	1270	1
Myrciaria dubia McVaugh (camucamu)	0	1	0	0	0	0	0	0	0	1	72
Myrciaria. sp. (de Jong 170, sacha camucamu)	0	1	0	30	0	0	0	0	0	31	36
MYRTACEAE (de Jong 179, lanza caspi)	0	0	0	10	0	0	0	0	0	10	55
Oenocarpus mapora Karst. (de Jong 17, vacavilla)	9	1	0	0	0	0	10	0	0	20	43
Ormosia amazonica Ducke. (de Jong 172, huayruro)	3	0	0	0	0	0	0	0	0	3	67
Passiflora quadrangularis L. (tumbo)	0	1	0	0	0	0	0	0	0	1	72
Phytolephas macrocarpa R.& P (yarina)	0	1	0	0	0	0	0	0	0	1	72
Pouteria caimito (R&P) Radlk. (caimito)	3	1	0	0	0	6	0	0	0	10	55
Psidium guayava L. (guayaba)	12	12	71	10	0	11	0	3	0	119	13
Pterocarpus amazonum (Benth.) Amshoff (de Jong 181, parinari)	0	0	0	20	0	0	0	0	0	20	43
Pterodium densiflorum (de Jong 182, casha moena)	0	0	14	0	13	0	0	1	0	28	38

Table 7.1, continued

Binomial, collection number and vernicular name	Agroforestry field										
	A	B	C	D	E	F	G	H	I	Tot	Rk
Rheedia sp. (de Jong 78, charichuelo)	16	1	5	0	0	0	0	0	0	22	41
Saccharum officinarum L. (caña)	3	0	0	0	0	0	0	0	0	3	67
Scheelea brachyclada Burret (Ruiz 1424, shapaja)	28	5	14	0	0	0	0	0	0	47	28
Senna multijuga (Rich.) I.& B. (Ruiz 1464, pashaco)	0	3	119	40	13	22	5	0	0	202	8
Sloanea laxiflora Spruce ex Benth. (de Jong 181, sepanchina)	0	0	5	0	0	0	0	0	0	5	61
Solanum sessiliflorum Dunal (de Jong 60, cocona)	47	1	0	0	0	0	0	0	0	48	26
Solanum stramonifolium Jacq. (de Jong 64 coconilla)	19	0	0	0	0	0	0	0	0	19	45
Spondias mombin L. (uvos)	0	5	0	0	0	0	0	0	0	5	61
S. dulcis L. (taperiba)	0	0	5	0	0	0	0	0	0	5	61
Syzygium malaccensis (L.) Merr.& Perry (mamey)	38	12	10	0	0	0	10	0	0	70	20
Tessaria integrifolia R.& P. (de Jong 102, pajaro bobo)	0	0	0	0	0	11	0	0	0	11	53
Theobroma bicolor Humb.& Bonpl. (macambo	3	5	5	10	0	0	0	0	0	23	40
T. cacao L. (de Jong 70, cacao)	3	12	14	0	13	6	0	0	0	48	26
T. obovatum Klotzsch ex Bernoulli (de Jong 156, cacahuillo)	6	0	0	0	0	6	0	0	0	12	50
VERBENACEAE (de Jong 167, mullo huayo)	0	1	14	20	40	0	0	0	0	75	18
Xylopia frutescens Aubl. (de Jong 171, espintana)	3	0	0	0	0	0	0	0	0	3	67
? (asna panga)	0	0	5	0	0	0	0	0	0	5	61
? (mamey limeña)	0	1	0	0	0	0	0	0	0	1	72
? (zorro caspi)	0	0	0	10	0	0	0	0	0	10	55
Total individuals	1042	254	1370	2390	478	1347	536	132	15		
Total species	40	43	31	23	18	23	15	6	3		

thatching, together with timareo (FLACOURTIACEAE, sp. indet.), a construction round wood species, *Ormosia amazonica*, yielding fruits used for handicrafts, and *Mansoa alliacea*, a medicinal herb. In the other mixed orchard (field B) *Myrciaria dubia* and *Spondias mombin* were grown. These are both edible fruits from neighboring forests which are harvested for consumption and sale in the market (Peters 1990; Peters & Vasquez 1989). Other managed forest species from this field are *Senna multijuga*, mullo huayo (VERBENACEAE, sp. indet.), and *Margaritaria nobilis*, which are used for construction.

The number of species in each of the nine floodplain agroforestry fields ranged from 68 in the mixed orchard field (field B) to five in the corn agroforestry field (field I; Table 7.1). The large number of managed species in the mixed orchard is a result using this field as both a mixed orchard and as a house garden. However, when analyzed separately, the agroforestry section of field B had 43 species. This number does not differ greatly from the number of species found in other mixed orchards in Santa Rosa (see chapter 6).

The important role of native forest species in Yanallpa agroforestry is also reflected in the distribution of all useful plants in all fields surveyed. No one species was found in all nine fields. However, three species were found in seven fields: plantains, *Cedrela odorata*, and *Genipa americana*. The latter is a native species found in a flooded forest habitat but which is commonly planted. Two tree species, *Mauritia flexuosa* and *Senna multijuga*, both also native to the floodplain, were present in six of the nine agroforestry fields. A total of 32 of the 78 species were present each in only one of the nine agroforestry fields surveyed.

Weeding patterns and yield levels

The intensive use of the two mixed orchards (agroforestry fields A and B) allowed very little weed invasion. Infrequent clearings kept most of the area of the two fields totally weed free. Products were harvested whenever available and needed. Fruit production of some species like the *Citrus paradisi* in the mixed orchard of field B exceeded household demand and some of the surplus production was sold. Some of the fruits, however, were not harvested at all. *Cedrela* *odorata* trees are harvested only occasionally.

The owner of mixed tree agroforestry field (field C) spent very little time weeding. Selected tree species, especially *Calycophyllum spruceanum*, were liberated from surrounding vegetation and occasionally cut. Fruit species were harvested whenever they yielded fruits. After the slash-weeding in 1987, however, the field was planted with manioc and plantain and was managed as a restinga chacra. Some of the smaller *Calycophyllum spruceanum* trees were tended just like they had been before the slash-weeding.

The *Cedrela odorata/Calycophyllum spruceanum* agroforestry field (field D), and the boundary-strip agroforestry field (field E) received little attention from their owners. The *Cedrela odorata* field had not been weeded for a long time, although the owner reported that he would soon start clearing areas around some of the cedar trees. Some incidental harvesting of trees for various domestic uses occurred from this field. The *Cedrela odorata* trees were not yet large enough to be harvested for timber. In the boundary-strip agroforestry field (field E) only fruits were harvested. Weeding was only carried out at the edges of the field to prevent the understory vegetation from entering neighboring fields.

The larger part of the plantain agroforestry field (field F) was slash-weeded about once per year, just like any regular restinga plantain field (see chapter four). A small part of this field received less care, resulting in a higher density of spontaneously occurring tree species. Plantains were harvested and replanted. Some of the smaller trees were ready to be used as construction material, but the larger *Cedrela odorata* trees were not harvested yet.

During the time of the inventory a dense weedy vegetation of grasses and kudzu (*Calopogonium caeruleum*) covered the second plantain agroforestry field (field G). Shortly after the field was surveyed the owner started a slash-weeding, and gradually the whole field was cleared. In 1989 the whole field was still without any significant weed vegetation. The owner reported that he conducted a similar clearing in this field about every four years, at which time he also replanted most of the plantains and some *Cedrela odorata* trees. The plantains were harvested whenever they yielded products.

The management activities of the mixed corn agroforestry fields focused on the corn crop. Weeding, planting and harvesting of corn followed a well-defined schedule (see chapter four). No management of *Cedrela odorata* trees was done other than the harvesting of the 35 trees in 1989. No replanting of trees in either of the fields was observed.

VARZEA AGROFORESTRY STRATEGIES

The agroforestry fields discussed above, are essentially of two different types. Fields A through E can be described as forest gardens since the larger part of the vegetation consists of trees. In these fields the focus is principally on tree production, albeit in combination with a significant number of non-tree species in fields A and B. On the other hand in fields F through I the main emphasis lies on producing plantain, manioc and corn. Trees are grown in addition to these annual or short-lived crops.

The combinations of common agricultural crops with trees in fields F through I are only possible because the soils of these fields allow such a mixture. Farmers choose to include trees in these fields because they see that the increase in value represented by the trees outweighs the inherent loss incurred to the annual crops. Trees in these fields are maintained at lower densities than in the plantain agroforestry fields because corn is less shade tolerant than plantain. Most of the trees in these fields are *Cedrela odorata* trees. This timber species has an open crown and sheds its leaves shortly after the high water period, just when the first corn crop is planted. As a result *Cedrela odorata* trees produce less shade than many other tree species.

In fields with a high chance of flooding crop combinations other than corn and *Cedrela odorata*, such as plantain with trees (like fields F and G) or mixed orchards (like fields A and B) are to risky. Another reason *Cedrela odorata* greatly dominates as a tree component in restinga corn fields is because this species has a high commercial value. This species is grown for timber, and sold to the sawmill in Requena. Since corn is a principal cash crop, farmers are less willing to interplant trees that will not increase economic returns from the field. Combinations of other open crowned tree species, and corn or manioc is also reported from Java where soil fertility is higher than in most locations where swidden fallow agroforestry is common (van der Poel & van Dijk 1987).

In the plantain agroforestry fields *Cedrela odorata* trees are grown together with several other tree species many of which are destined for local use. Plantains grown on the fertile varzea soils are less affected by shade than a corn crop and can grow under a more dense canopy cover. Plantains are a less important cash crop than corn. The additional returns of various tree products destined for household consumption justifies a decrease in the production of the plantain.

Of the forest gardens described above, the mixed orchards (fields A and B) occur on the higher parts of the levee, and could not occur on sites which experience more frequent flooding, since this would too often destroy many of the non-tree species present. Tree species which are common in upland forest gardens, but which do not tolerate the infrequent flooding, are absent from these two fields. Although species compositions are different in each, the Yanallpa agroforestry fields A and B provide the owners with a similar range of products as the orchards in Santa Rosa, or other home-gardens reported from elsewhere (e.g. Soemarwoto and Soemarwoto 1984; Christanty et al. 1986; Wiersum 1983; Fernandes et al. 1987).

During most of the life cycle of the mixed-tree agroforestry field (field C) trees were grown in combination with annual crops or manioc. During the period without manioc, the emphasis was shifted to tree production. When the field had been cleared again the larger *Cedrela odorata* trees were maintained and so were some of the smaller *Calycophyllum spruceanum* trees. Hence in this field permanent tree crops are combined with a cyclic planting of manioc and plantain. In fact, the field is partly fallowed for manioc and plantain. During such a quasi fallow period attention to aspects of tree production, especially of *Calycophyllum spruceanum*, is intensified.

The field dominated by the *Cedrela odorata* /*Calycophyllum spruceanum* vegetation (field D) is managed solely for the production of these tree species, although some additional tree species are allowed to grow. The site could be used for corn production, which would provide much faster monetary returns, but the owner preferred not to because he had enough other fields in which he could produce rice and corn. If the owner would not have enough land, this field would probably be converted into a mixed corn/*Cedrela odorata* agroforestry field. A mixed orchard, or plantain/*Cedrela odorata* agroforestry is not viable on this site, because it is subject to frequent flooding.

Since the main function of the boundary-strip agroforestry field (field E) is to separate areas of land belonging to different owners, economic returns are less important than in the other fields. As a consequence these sites generally receive little attention and weeding from their owners. In many such fields *Artocarpus incisa* has a prominent presence. This species, originally from Asia, is an important food source when no other staples are available. A shortage of staples may arise when a very high flood destroys all plantain fields, as occurred in 1986. In time of abundance, fruits of this tree species are fed to domestic animals.

OPTIONS FOR VARZEA AGROFORESTRY DEVELOPMENT

The special circumstances in the floodplain allow several other agroforestry options which are not feasible in terra firme. Since there is no permanent cropping of annuals on the latter, combinations of short cycle crops and trees are unusual. Occasionally, terra firme farmers leave trees standing when slashing new swiddens (Denevan et al. 1984), and such practices are also found among Santa Rosa farmers. However, even such initially open agroforestry swiddens will eventually develop into closed forest gardens. Hence the most obvious difference between Santa Rosa and Yanallpa agroforestry is the permanent mixture of annual crops and tree crops in the latter.

The second notable difference between Yanallpa and Santa Rosa agroforestry is the larger role of native forest species in Yanallpa. *Cedrela odorata* and *Calycophyllum spruceanum*, the native forest species most common in Yanallpa agroforestry appear spontaneously in fields in the varzea and are easily incorporated in the management. Yanallpa farmers' stronger focus on these species is also explained by their decreased access to forests as a source of products for their daily household use. It therefore makes economic sense to grow such species, even if limited field space must be used for such a purpose. Furthermore, *Cedrela odorata* has a market value, grows fast in the varzea lands, and can be grown in combinations with many other crops, including light demanding ones like corn or even rice. Agroforestry species in the two villages have a similar range of uses, but market-oriented timber production is more important in Yanallpa.

The variation in agroforestry practices in Yanallpa allows for more development possibilities than in Santa Rosa. An increase of cash income can be achieved through improved production of *Cedrela odorata*. Some simple silvicultural measures like pruning, or selection of improved planting material achieve this. Besides improving existing practices, combining *Cedrela odorata* with different cash crops should be tried. Moreover, production for household consumption, or for sale in Yanallpa itself or in neighboring villages, may improve the income of some farmers. The lack of forest resources within close vicinity of Yanallpa, and the interest of farmers to produce those forest products themselves indicates that such agroforestry practices oriented towards household consumption are possible in Yanallpa. Production of *Calycophyllum spruceanum*, for instance could satisfy both a local and a regional need.

Just like in Santa Rosa, agroforestry in Yanallpa will continue to be a variable business. No single improved system can possibly be earmarked as the best and only alternative. Rather, several of the practices discussed above should be used as a base for the development of improved systems which can increase either cash income or the supply of locally needed resources. It should be kept in mind, however, that in Yanallpa, any new agroforestry strategy will always have to compete with other land-use options. New agroforestry practices will only be adopted if they provide returns which are valued higher than returns from other agricultural types.

CHAPTER EIGHT

CONCLUSIONS AND PROSPECTIVE

INTRODUCTION

The fate of the world's natural resources is currently a great concern. The potential consequences of the unsustainable use of these resources for large parts of the populations, especially of lesser developed countries urgently demand modification of current ways and levels of exploitation. Todays problems of resource depletion, degrading environments, and related decreases of the living standard of many rural populations are already such that direct intervention is needed (National Research Council 1992). However, as a result of the increased complexity of problems concerning the sustainable use of natural resources, solutions must become more sophisticated. In many cases, such solutions have to be site-specific, requiring a profound understanding of local conditions and possibilities. Consequently, research which provides the required information for such understanding remains paramount.

In this book a study is reported of the diversified use of natural resources by ribereños of the Peruvian Amazon. The varzea, or periodically flooded plains along the Amazon, are now becoming an important area for agricultural development. Unless methods are developed to use this area wisely, the increased exploitation of the floodplain will lead to both environmental and social destruction. This present study attempts to contribute to basic information on the complex resource management practices of local farmers who inhabit and exploit varzea lands. It is hoped that, by learning their methods, we will be able to benefit from the riches of the Amazon landscape without ending up overtaxing them.

Most research in the varzea has been conducted by two different groups of scientists. On the one hand, agronomists and developers became interested in this ecological zone as a possible location for the development of modern agriculture.

Their interest was mainly triggered by the fertile soils of the varzea, compared to the low fertility of the terra firme soils. On the other hand, archaeologists studied the varzea as the main route of human occupation of lowland Amazonia. Scientists of both groups formulated theories concerning resource utilization of the Amazon floodplains, some of which have been summarized in chapter one. It is assumed in this book that examples of contemporary varzea resource exploitation can contribute to the theories about future or past varzea exploitation. Such theories have insufficiently been tested against contemporary use. This is, to a large extent, a result of the general belief that present varzea resource use is virtually absent (e.g. Ross 1978). Other studies (e.g. Hiraoka 1985a,b, Bergman 1974), as well as the present study proves such belief to be untrue.

In this book, resource management among ribereños was investigated. Ribereños are rural, non-tribal, indigenous people who live in isolated villages most of which are located along the larger river systems of the Peruvian Amazon. Among these people variability can be observed in, for instance, degree of acculturation, local history, and involvement with regional economies. However, a number of general common features justify their distinction as a separate economic and cultural group (Chibnik 1991). Ribereños practice agriculture, fishing, hunting and collecting for both household consumption and markets. Their resource management practices, however, have been ignored by the scientific community until recently. Since ribereños are the largest group of rural inhabitants in the Peruvian Amazon, they play an important role in the regional economy. This role can be expected to increase in the future. Ribereños are also the group that will mostly be affected by any expansions of government sponsored industrial agriculture. Development of the varzea in the Peruvian Amazon should start in collaboration with ribereño farmers. This will not only lead to a more equally distributed development, but it will also benefit from an accumulated experience and understanding of the environment and its potentials.

In this last chapter the most important findings and their implication for some of the theories that have been formulated earlier concerning varzea resource exploitation will be summarized. The research which is at the base of this book will briefly be assessed. Finally some thoughts will be given to possible scenarios of the future of ribereño agriculture, and the possible implications of this study for development or extension efforts among the riverine population of the Peruvian Amazon.

SUMMARY OF FINDINGS

Agricultural diversity

This study investigated the adaptation of ribereños to a complex and dynamic varzea and adjacent terra firme. Specifically, it documented and analyzed diversity in agricultural practices, variation in agricultural strategies, and diversity in agroforestry practices in two ribereño communities in the lower Ucayali river of Peru. Agricultural diversity, variation in agricultural strategies, and diversity in agroforestry practices could adequately be demonstrated, but could only partly be explained. This is not a consequence of insufficient, or inappropriate research, but rather of the complexity of ribereño agricultural practices.

The principal factor determining the complexity of ribereño agriculture is the ecological diverse environment in which ribereños live. Especially in the varzea, the land forms which are appropriate for agriculture can be planted to different crops, and require totally different farming techniques. As a consequence agricultural practices vary according to land form. Among the economic factors which influence agricultural complexity, market opportunities are essential. Ribereños are the suppliers of many agricultural and forest products for local markets. Demands for products and prices vary and ribereños are sensitive to such fluctuations. One of the social factors which increase agricultural complexity in the Peruvian Amazon is the high mobility of ribereños. Many of these riverine people have lived in more than one location during their life time. Migrating to the city and back to the countryside, but also relocation to a different village is common. This mobility also leads to an increased complexity of ribereño agriculture.

Agricultural diversity among ribereños could be adequately demonstrated by describing fourteen different agricultural types. An agricultural type is defined as a unique site-crop combination which has its own specific set of agro-economic characteristics. Four of these agricultural types were located on terra firme lands and ten in the floodplain. Ecological conditions of sites, as well as economic opportunities determine the crops which ribereños will grow, and where. A specific site and crop combination implies its own specific allocation of labor, economic returns, and risk of failure. A large part of the primary research described in the present book focused on quantifying the agro-ecological and agro-economic characteristics of the fourteen agricultural types.

Agricultural diversity is a common characteristic of ribereño agriculture. By definition, this characteristic is neither uniform nor static. Since ecological conditions as well as economic opportunities vary in almost any other place in the Peruvian Amazon, it is unlikely that in other ribereño villages any identical form of diversity will be found. This appeared, for instance, from the comparison of agricultural diversity in Santa Rosa and Yanallpa. It is also unlikely that in the future the same agricultural types which are described here will continue to have the same importance in Santa Rosa and Yanallpa: while the ecological complexity of the environment will probably remain the same, economic opportunities will change. Consequently agricultural practices will and do alter. This could already be observed between 1985 and 1989.

Variation in agricultural strategies

A second level of agricultural complexity is the variation in agricultural strategies among individual ribereño farmers. Variation of agricultural strategies is a result of individual responses of farmers to the many options available, and therefore a direct result of the agricultural diversity. Ribereño farmers are unique in that the variation in agricultural strategies that can be found within a single village exceeds case studies reported from elsewhere (e.g. Barlett 1982).

The large variation in agricultural strategies among ribereños made it difficult to understand the rules which govern this phenomenon. No one variable explains all the observed variation. Instead, various interacting factors influenced the way ribereños farmed in Santa Rosa and Yanallpa. Ribereños generally grow their own staple food, mainly manioc and plantains, and they produce crops to be sold in the market. Production of food for household consumption and growing crops for monetary income are mostly carried out in different agricultural types. Agricultural strategies are further influenced by availability of labor, access to land, availability of bank loans, and the willingnes to take risk.

Not all farmers have their principal food-producing fields on terra firme, although these sites have the lowest risk for growing manioc. To gain easier access to lands, many farmers relocate both food and cash crop production to the floodplain. If this happens, than food production is often carried out in more than one agricultural type. This lowers the risk that all the fields with food crops will be innundated, which would leave the household without a daily staple.

In Santa Rosa and Yanallpa, most of the cash cropping occurred in the floodplain. Principal cash crops, during the time of research, were rice, corn, and to a lesser extent plantains, jute, and vegetables. Ecological factors largely accounted for the difference of rice being the principal cash crop in Santa Rosa, while in Yanallpa corn, rice and plantain were the principal cash crops. In Santa Rosa more land was appropriate for rice production than in Yanallpa. Ribereño farmers accepted the higher risk of growing rice in barreales, the annually appearing mudflats, as a trade-off for higher returns for invested labor. However, only a limited number of farmers had access to this preferred land type. Those who did not have access to barreales had to rely on other agricultural types to obtain cash. Farmers have to wait sometimes for many years before they can buy a barreal from another farmer, or until new barreales are formed by river dynamics.

Diversity in ribereño agroforestry

Agroforestry practices differed between Santa Rosa and Yanallpa, and in each village they showed important variation. In Santa Rosa, variation in swidden-fallow agroforestry could be demonstrated by comparing the densities of managed plant species, weeding patterns, and production levels of a number of terra firme agroforestry fields. Although some of the forest gardens in Santa Rosa were intensively tended, forest gardens with very low management intensity still provided important economic returns from species planted in the previous swiddens. The more important role of swidden-fallow agroforestry in Santa Rosa, compared to other locations from Peru and Ecuador (e.g. Denevan & Padoch 1987; Irvine 1987) is a consequence of the higher pressure on forest resources in Santa Rosa, and a higher involvement of ribereño farmers in the regional market economy. This results in an economic incentive to produce a number of fruit species and forest products in forest gardens, which therefore are given more attention. The variation in agroforestry practices within the village is a result from these practices being oriented toward production for household consumption. As a consequence, farmers have different preferences in how much labor they want to invest in forest gardens. Santa Rosa inhabitants will not easily find possibilities to become market-oriented agroforesters, as ribereños who live close to Iquitos have (Padoch et al. 1985; Hiraoka 1986).

In Yanallpa, fewer farmers had agroforestry fields than in Santa Rosa. In Yanallpa arable land is scarce, while alternative land-use options always exist for fields which are destined for tree growing. Agroforestry fields in Yanallpa had a more permanent character than in Santa Rosa, but were also more integrated with other agricultural activities. Agroforestry practices in Yanallpa included the growing of corn, manioc, and plantains together with trees in single fields. Growing of *Cedrela odorata* trees for commercial purposes was more important in Yanallpa than in Santa Rosa. Among agronomists, agroforestry in the floodplain is still quite novel and unexplored, but it appears to have great potential for further development. Especially the combination of trees with other agricultural crops offers an interesting prospective.

IMPLICATIONS FOR THEORIES ON VARZEA RESOURCE USE

Varzea agriculture in Peru versus Brazil

The contradiction between the complex and diversified use of the varzea by ribereños in Peru on the one hand, and the limited uses of this ecological zone which is found among caboclos in Brazil, (Wagley 1953; Ross 1987; Frechione et al. 1989; Bunker 1981; Wesche 1985) is remarkable and requires an explanation. More recent studies conducted around Manaus (Bahri et al. 1991) indicate that at least in certain locations the Brazilian riverine populations have developed diversified agricultural activities comparable to those found in the Peruvian Amazon. It should not be excluded that some reports of the absence of varzea agriculture in Brazil were based on insufficient field work. But even if Brazilian varzea activities are still insufficiently documented, then it still appears that utilization of the Amazonian floodplains by non-tribal indigenous populations is more developed in Peru than in many parts in Brazil.

The observed dissimilarity in varzea occupation and use can be explained by the differences in historical and economic processes in the Peruvian versus the Brazilian Amazon. Although the native populations in both regions suffered severe impacts resulting from Europeans exploiting forest products and slaves, these impacts were more severe at an earlier time in the Brazilian Amazon (Parker 1981; Meyer 1988). During the nineteenth century the floodplain of the whole Amazon region had low population densities. The populations of the Brazilian region, however, had already experienced more profound cultural changes than the people from the upper Amazon.

The impact of Europeans on the lives of upper Amazonian groups changed dramatically with the coming of the rubber boom around the turn of the century. During this period the local populations in the upper Amazon experienced an impact which was at least as severe as groups in the Brazilian Amazon had undergone a century or two earlier. The rubber boom also brought a large number of migrants from elsewhere to the region. Once exploitation of rubber had ceased, a large group of people who had come to the floodplain to participate in rubber exploitation stayed in the area. During the following decades, many local dwellers lived and worked on larger agricultural estates which emerged following the eloxpitation of rubber. When these river dwellers became independent farmers they were acclimated to varzea agriculture, and to active participation in regional economies. Since the nineteen-sixties, market opportunities for agricultural products have improved as a result of increased urban populations in small and large cities, as well as improved river transportation. During the late sixties and early seventies the government promoted commercial agriculture in the region. As a response, ribereños experimented with new agricultural methods, and with the cultivation of conventional and novel crops, often on sites which had not been used for agriculture before. This lead to the present diversification of agricultural activities, as described in this study.

Requirement of complex social organization for varzea exploitation

Meggers (1974), and with her Ross (1978), and Roosevelt (1980), have argued that pre-contact groups could subsist in the floodplain because they had chiefdom like social organizations in which persons of higher status coordinated subsistence activities. Such coordination was considered necessary to be able to cope with the constraints of the varzea, especially with the unpredictability of floods. This lack of social organization was one of the reasons which, according to Ross (1987), accounted for the lack of any significant agriculture in the floodplain.

This study presents an example of complexity of ribereño agriculture which contradicts that a complex social organization is a requirement for varzea agriculture. Not only do ribereños operate as independent farmers, their agricultural strategies are also individualistic. Technological differences between pre-contact groups, and contemporary ribereños are still minimal. Although ribereños do diversify their agriculture partly because they produce for an external market, this only increases the complexity of their agriculture further, as has been argued above. Hence pre-contact agriculture was probably less complex. The more complex varzea exploitation does not hinder ribereños in still continuing their independent farming.

Unfortunately there are no exact and comparable figures on population densities, but it is questionable whether, during pre-contact periods in the upper Amazon, population densities of floodplain groups were higher than they are today. At present the Peruvian Amazon sites which are appropriate for living are all occupied. If during pre-contact periods such higher densities would have occurred, the distribution of limited resources, like land or harvests, may have required persons with higher social status. It would not have made it impossible for farmers to operate independently from the larger group. No complex societies with social stratification are necessary to practice complex agriculture in the floodplain.

It could even be argued that individualistic farming is more efficient in the floodplain. The use of several land forms not only allows farmers to differentiate production, but also to spread labor adequately so that it best fits the farmers own labor pool and to minimize the risk of crop failure. Some of the agricultural types require precise scheduling, since only a very limited time is available to produce a certain crop in a certain site. Given the complexity of the environment, agricultural decisions are site-specific. This requires a precise monitoring of agricultural fields. If decisions concerning agricultural activities would be made by an authority or the whole group, then the process of information gathering, decisions making, and implementation would necessarily have taken longer. Such a process would therefore likely make agricultural activities in the floodplain less successful than single-household farming.

Dependence of pre-contact groups on corn protein

Data on the diversity of agricultural methods challenge the ecological evidence which Roosevelt (1980) used to support her hypothesis concerning the seed-crop based subsistence strategies of pre-contact groups. As shown by Bergman (1974; 1980), Hiraoka (1985a,b, 1986), and in the present book's chapter four, production of corn and manioc are not at all incompatible in the floodplain. Many higher restinga sites are sandy and are inundated only during extremely high floods. They allow manioc production for as long as 10 months, while production levels of single crops are the same as in terra firme fields. Although many ribereños in Santa Rosa and Yanallpa grew corn and rice in 1985/1986 and 1989, they subsisted largely on manioc or plantain together with fish, even during high water periods. A one hectare field planted with regional corn varieties yields no more than 1800 kg, or about 180 kg of low quality protein. This production however requires no less than 85 labor days with the technology used by ribereños today. This is the equivalent of a ratio of 2.1 kg of protein per labor day. Reported catch levels of Shipibo varzea inhabitants exceed 0.5 kg of fish per hour (Bergman 1974), an efficiency rate much higher than in corn protein production.

It is unlikely that on a regional level total fishing catch levels during pre-contact periods were higher than they are today. Today commercial fishermen, using modern equipment, provide fish for large populations in cities like Iquitos, Manaus and Pucallpa during the whole year. Even if pre-contact groups lived in higher densities in the varzea, with the fishing techniques they had available they probably did not overfish their fishing grounds to such an extent that catch levels, as reported among Shipibo fishermen, were severely reduced. A denser pre-contact population most likely could subsist well on a fish and manioc diet, as do most riverine people in Peru today. Corn obviously was an important part of pre-contact diets (Roosevelt 1980; 1989), but the ecological evidence contradicts the hypothesis that larger pre-contact populations could only develop because they changed to a seed-based diet.

EVALUATION OF THE RESEARCH

In this study agricultural diversity and variation in agricultural strategies among ribereño farmers in Peru has been demonstrated. This means that its objectives have been fulfilled. In order to grasp the complexity of ribereño agriculture it was necessary to find an organizing concept. The concept of "agricultural type" has proven to be an adequate tool for both the study of agricultural diversity as well as variation in agricultural strategies. Using the agricultural type concept the many farming methods observed among ribereños in Santa Rosa and Yanallpa can adequately be described, and their agro-ecological as well as agro-economic features can be characterized.

Each of the agricultural types described has a specific set of agro-economic characteristics. A farmer who combines several specific agricultural types not only chooses certain production types, but also decides for a specific allocation of resources. Agricultural strategies were defined as the individual allocation of such resources, and therefore the agricultural type concept also was proven to be useful in the analysis of variation in agricultural strategies. The agricultural type concept could be used for both the analysis of agricultural diversity and variation in agricultural strategies, because its definition assumes a functional relation between the technological features of agricultural production types and the related agro-economic characteristics.

Participant observation and interviewing of farmers were the methods used for the quantification of the agro-ecological and agro-economic characteristics of agricultural types. These quantifications could be improved using direct measurements of a sufficient large selection of fields belonging to each agricultural type. This would require much more time and more researchers. Because of the large number of agricultural types described, it was not possible to do such measurements in this study. Since some of the agricultural types were more common than others, more data could be gathered on the common ones. Hence, the accuracy of information presented here differs for each agricultural type.

A more thorough quantification of ribereño agricultural types will also result in a better understanding of the variation of agricultural strategies among ribereño farmers, since the economic implications of certain choices will be understood better. However, since agricultural strategies are very individualistic, as has been demonstrated in chapter five, a much closer monitoring of individual farmers will have to be conducted to be able to fully understand agricultural strategies. It is questionable whether ribereño agriculture can ever be understood so well that farmer's behavior can be predicted. Ribereños are very dynamic in their agricultural strategies because they have to be very opportunistic as a consequence of the highly variable ecological and economic environment.

In the discussion of diversity in agroforestry practices, the composition of agroforestry fields, their yield levels, and the weeding schedules followed were compared. For the comparison of composition of agroforestry fields a distinction was made between managed and non-managed vegetation. Swidden-fallow agroforestry fields are covered with a mix of trees, shrubs, and weeds. Some, but in most cases not all of this vegetation is purposely and actively tended. The procedure for the distinction of the managed versus non-managed vegetation has been described in chapter two.

The comparison of the composition and yield levels of only the managed vegetation excludes a non-managed vegetation which may be considerable in some forest gardens. Such vegetation does have an economic importance. However, comparing only the managed vegetation is consistent with the practice of forest garden exploitation used by the Santa Rosa and Yanallpa inhabitants. For this exploitation the word *purmear* is used. Purmear means going to a forest garden to harvest products which one knows are there because they were planted or tended. Collecting other forests products from the spontaneous non-managed vegetation occurs but, at least in Santa Rosa and Yanallpa, it does not have the same economic importance as harvesting managed species. A comparison of the managed vegetation of Santa Rosa and Yanallpa forests gardens is therefore in fact a comparison of the relative economic importance of these forest gardens.

Weeding patterns of the Santa Rosa terra firme forest gardens were measured by looking at changes in the status of the non-managed weed vegetation. The relative cover and height of the non-managed vegetation were estimated every three months for single fields. From the changes observed a management pattern was derived. The procedure used for this estimation has also been explained in chapter two.

A novel method to estimate yield levels of agroforestry fields was also implemented. Every three months in transects in agroforestry fields, the produce which could be harvested from the field in the next three months was estimated. This method allowed to obtain yield estimates without having to rely on more difficult methods like labeling of fruits, using fruit traps, or recording of products harvested by users of forest gardens. Marking and collecting fruits has to be done with painstaking precision, and therefore is more time-consuming. Even the latter method still can lead to errors when, for instance, fruits are harvested by children, or other people who pass through the forest. Recording of produce harvested by owners is much less accurate since usually many people, other than the owner, harvest from forest gardens. Estimating future production for the next three months is less accurate than counting, but errors are within acceptable limits for the purposes required.

THE FUTURE OF VARZEA AGRICULTURE IN AMAZONIAN PERU

Accelerated changes of the ribereño society and economy began in the 1950's when improved transportation and communication, increasing demands for the areas' resources, and governmental regional integration and development attempts began to affect many facets of ribereño life and environment (Hiraoka 1985b). Ribereños livelihood activities became adapted for a market-oriented economy. Hiraoka (1985b) expected that in the Peruvian Amazon the streamlining of agricultural land-use would increase disparities in access to land and wealth, and stimulate rural emigration to cities and changing flora and fauna. Among caboclos in Brazil such changes have been reported (Wesche 1985; Bunker 1981; Schmink 1985). In the vicinity of Manaus opening of roads to caboclo communities has lead to "a progressive destabilization of the livelihood of caboclo society" (Wesche 1985: 136). Urban migration increased, and caboclos have become participants in an incipient labor class (Wesche 1985). The market oriented caboclo communities in central Amazonia are not able to resist pressure from a powerful local entrepreneurial class which dominates local economies especially affecting traditional caboclo cash activities and taking over most of the land (Bunker 1981). It remains to be seen whether such developments will occur in Santa Rosa and Yanallpa.

An increased economic stratification of rural communities is taking effect in the area around Iquitos. Increasingly, local entrepreneurs are dominating the agricultural economy. As a consequence land conflicts and even expulsions of farmers from the terrain they farm have become more common (Chibnik 1990). Unclear land tenure, lack of access to bank loans, or unfamiliarity with government agencies make many ribereños less competitive than larger farmers from the villages or the city. These are signs of similar process that may lead to destabilization of ribereño livelihood as described by Wesche (1985) for caboclos in Brazil.

Changes, as noticed by Hiraoka, in ribereño communities close to Iquitos began in Santa Rosa and Yanallpa during the mid- and late sixties. However, because of their geographic isolations, and because of recent developments in the Peruvian economy, changes, such as occurred among caboclos in Brazil and which are taking place in the vicinity of Iquitos, are not likely to occur soon in villages on the lower Ucayali river. Although upstream from Requena larger farmers or *patrones* still appear to dominate local economic life in some villages, the owner of the Monte Carmelo agricultural estate, just North of Santa Rosa, had stopped most of his activities by 1990. No larger entrepreneurs will find incentives to invest in agricultural production in this region, since there are too few market opportunities in a city like Requena. Transportation costs are too high to ship agricultural produce to larger markets.

It is also unlikely that increased economic stratification of farmers within any of the villages will occur soon. Net monetary returns for cash crops have decreased the last several years, especially since the government agencies in charge of buying rice was dissolved. Although an official price still exists for rice, local intermediaries pay as little as half or a third of this price. The agricultural bank does not provide any loans to small agriculturist anymore. Rather than increasing income inequality, current tendencies appear to lead to a homogenization of the economic levels of individual ribereños.

Because of declining prices for agricultural products, incomes among ribereño farmers have dropped the last several years, and will probably continue to do so. Because of the decrease in economic activities in this part of Peru there will be less economic interchange between the lower Ucayali region and Iquitos. The accelerated urban migration of the early seventies has stopped. Although many young people still go to the city to complete secondary education, their number will probably decrease because of declining income levels.

Changes in Santa Rosa and Yanallpa will mainly be the result of internal regional processes. Of the two villages studied, the largest changes can be expected to take place in Santa Rosa. Plans for a road connection of this village to Requena have existed for a long time. If this road is finally built, then more inhabitants of Santa Rosa will live in the city, and become migrant farmers. Subsequently, they would spend less time doing agricultural activities, which would lead to a general decrease of the complexity of their agricultural enterprises. Such farmers would probably maintain one cash crop and a food producing agricultural type, or even only one of the two. If no road connection will be established soon, then Santa Rosa farmers will continue to look for opportunities to obtain cash income, by means of agricultural or other activities. Their agriculture will continue to be opportunistic, and therefore diversified and dynamic, as it was between 1985 and 1989. The same is also true for Yanallpa farmers.

Ribereño agriculture can most certainly be improved. Unfortunately, agricultural research and extension in the Peruvian Amazon lacks precise focus on the real problems and possibilities of local farmers and conditions. One of the main research projects of the Ministry of Agriculture continuous to be production of water buffaloes in upland and varzea terrain. Production of buffaloes is not necessarily a bad idea, as long as it is investigated and promoted on a small scale, as was attempted previously at the Jenaro Herrera Research Station. Otherwise it will benefit only a few and bring no development for larger groups of riverine farmers. The local station of the *Instituto Nacional de Investigacion Agricola* has no research projects in the varzea yet (Mendoza and Pinedo unpublished). At the University of Iquitos and at the *Instituto Veterinario de Investigacion Tropical Amazonica* a few promising experimentation and extension projects are being carried out. One of these includes, for instance, production of *Myrciaria dubia*, a riparian shrub of which the fruits have a high content of vitamin C, but in the past has mainly been harvested in the wild (Peters 1990).

It is these kinds of smaller projects that can improve ribereño agriculture. Local research and extension agencies should recognize that ribereño agriculture is diversified, and they should offer a package of research and assistance for many of the activities that ribereños undertake. Ribereños have no need for large scale or capital intensive agricultural methods. Caboclos and ribereños are the best adapted inhabitants of the floodplain and thus the most valuable intermediaries for technological change and transfer in this region (Hiraoka 1992). But this technological change should start from existing resource management practices already present in the varzea. What ribereños need is a development which starts from their problems, knowledge and skills.

LITERATURE CITED

Alcorn, Janis B. 1990. Indigenous agroforestry strategies meeting farmers' needs. In: A.B.Anderson (ed.) Alternatives to deforestation: Steps toward sustainable use of the Amazon rainforest, pp 141-151. Columbia University Press, New York.

Ali, Abu M.S. 1987. Intensive paddy agriculture in Shyampur, Bangladesh. In: B.L. Turner II and S.B. Brush (ed.) Comparative farming systems, pp 276-306. The Guilford Press, New York.

Allen, Bryant J. 1985. Dynamics of fallow succession and introduction of robusta coffee in shifting cultivation areas in the lowlands of Papua New Guinea. Agroforestry Systems 3:227-238.

Anderson, Anthony B. 1990. Extraction and forest management by rural inhabitants in the Amazon estuary. In: A.B.Anderson (ed.) Alternatives to deforestation: Steps toward sustainable use of the Amazon rainforest, pp 65-85. Columbia University Press, New York.

Anderson, Anthony and Mario Augusto G. Jardim. 1989. Costs and benefits of floodplain forest management by rural inhabitabts in the Amazon Estuary: A case study of açai palm production. In: John O. Browder (ed.) Fragile lands of Latin America, pp 114-129. Westview Press, Boulder.

Anderson, A.B., A. Gely, J. Strudwick, G.L. Sobel and M.G. Pinto 1985. Um sistema agroflorestal na varzea do estuario amazonico (Ilha das Onças, Municipio de Barcarena, Estado do Para). Acta Amazonica, Supplement, 15(1-2):195-224.

Andriesse, J.P. 1979. From shifting cultivation to agroforestry or permanent agriculture. Royal Tropical Institute Bulletin, 303:35-43.

Aramburu, Carlos E. 1984. Expansion of the agrarian and demographic frontier in the Peruvian selva. In: M.Schmink and C.H.Wood, (eds.) Frontier expansion in Amazonia, pp 153-179. University of Florida Press, Gainesville.

Bahri, S. 1988. Les systèmes agroforestiers. In: Conditions écologiques et économiques de la production d'une ile de varzea: l'ile de Careiro, pp 336-347. ORSTOM, INPA, CEEE.

Bahri, S, F. Grenand, P. Grenand, J. Guillaumet, M. Lourd. 1991. La varzea est-elle un don de l'Amazonie? In: J.Gallais et al. Sahel Nordeste Amazonie: Politiques d'aménagement en miliux fragiles, pp 104-144. UNESCO, Paris.

Balée, W.L. 1984. The persistence of Ka'apor culture. Dissertation Columbia University New York. University Microfilms International, Ann Arbor.

Barlett, Peggy F. 1977. The structure of decision making in Paso. American Ethnologist 4:285-307.

Barlett, Peggy F. 1980a. Adaptive strategies in peasant agricultural production. Ann. Rev. Anthropol. 9:545-573.

Barlett, Peggy F. 1980b. Introduction: Development issues and economic anthropology. In: Peggy Barlett, (ed.) Agricultural decision making: Anthropological contributions to rural development, pp 1-18. Academic Press, New York.

Barlett, Peggy F. 1982. Agricultural choice and change: Decision making in a Costa Rican community. Rutgers University Press, New Brunswick.

Barrow, C.J. 1985. The development of the varzeas (floodlands) of Brazilian Amazonia. In: J. Hemming (ed.) Change in the Amazon basin vol 1: Man's impact on forests and rivers, pp 108-128. Manchester University Press, Manchester.

Beer, J., R. Borel, and A. Bonneman. 1990. On-farm agroforestry research planning in Costa Rica. In: W.W. Budd et al. (eds.) Planning for Agroforestry, pp 58-78. Elsevier, Amsterdam.

Bergman, Ronald W. 1974. Shipibo subsistence in the upper Amazon rainforest. Dissertation dep. Geography Unversity of Wisconsin. University Microfilms International, Ann Arbor.

Bergman, Ronald W. 1980. Amazon economics: The simplicity of Shipibo Indian wealth. Dellplain Latin American Studies 6. University Microfilms, Ann Arbor.

Bishop, J.P. 1983. Tropical forest sheep on legume forage/fuelwood fallows. Agroforestry Systems 1:79-84.

Boerboom, Jan H.A. 1974. Succession studies in the humid tropical lowlands of Surinam. In: Proceedings of the first international congress of ecology, Den Haag. Wageningen.

Boonkird, S.A., E.C.M. Fernandes, and P.K.R. Nair. 1984. Forest villages: an agroforestry approach to rehabilitating forest land degraded by shifting cultivation in Thailand. Agroforestry Systems 2: 87-102.

Bourke, R. M. 1985. Food, coffee and casuarine: an agroforestry system from the Papua New Guinea highlands. Agroforestry Systems 2: 273-279.

Boserup, Ester. 1965. The conditions of agricultural growth. Aldine Publishing Company, Chicago.

Brown, M.F. 1984. Una paz incierta: Historia y cultura de las comunidades Aguarunas frente al impacto de la carretera marginal. CAAAP, Serie Antropologica No 5, Lima.

Budd W.W. et al. (eds.) 1990. Planning for agroforestry. Elsevier, Amsterdam.

Buck, L. 1990. Planning agroforestry extension projects, the Care International approach in Kenya. In: W.W. Budd et al. (eds.) Planning for agroforestry, pp 101-131. Elsevier, Amsterdam.

Bunker, Stephen G. 1981. The impact of deforestation on peasant communities in the Medio Amazonas of Brazil. In: Where have all the flowers gone: Deforestation in the Third World. Studies in Third World Societies 13: 45-60.

Bunker, Stephen G. 1984. Underdeveloping the Amazon. University of Illinois Press, Chicago.

Burley, C.F.I. and P. Von Carlowitz. 1983. Multipurpose tree germplasm. ICRAF, Nairobi.

Calzada Benza, Jose. 1981. 143 frutales nativos. Lima

Cancian Frank. 1988. Economic behavior in peasant communities. In: Steward Plattner (ed.) Economic anthropology, pp 125-170. Stanford University Press.

Casanova, J. 1975. El sistema de cultivo Secoya. In: P. Centlivres, J. Gasché and A. Lourteig (eds.) Culture sur brûlis et évolution du milieu forestier en Amazonie du Nord-Ouest, pp 129-143. Bulletin de la Société Suisse d'Ethnologie.

Cashdan, Elizabeth. 1990. Introduction. In: E. Cashdan (ed.) Risk and uncertainty in tribal and peasant economies, pp 1-16. Westview Press, Boulder.

Cavalcante. 1976, 1978, 1980. Frutas comestiveis da Amazonia. Vol I, II, III. Museo Paraensis Emilio Goeldi, Belem.

Chayanov, A.V. 1986. The theory of peasant economy. The University of Wisconsin Press, Madison.

Chibnik, Michael. 1990. Double-edged risks and uncertainties: Choices about rice loans in the Peruvian Amazon. In: E.Cashdan (ed.) Risk and uncertainty in tribal and peasant economies, pp 279-302. Westview Press, Boulder.

Chibnik, Michael. 1991. Quasi-ethnic groups in Amazonia. Ethnology.

Chibnik, M. and W. de Jong. 1989. Agricultural labor organization in ribereño communities of the Peruvian Amazon. Ethnology 28:75-95.

Christanty, Linda. 1986. Shifting cultivation and tropical soils: Patterns, problems, and possible improvements. In: G. Marten (ed.) Traditional agriculture in Southeast Asia: A human ecology perspective, pp 226-240. Westview Press, Boulder.

Christanty L., O.S. Abdoellah, G.G. Marten, and J. Iskander. 1986. Traditional agroforestry in West Java: The pekarangan (homegarden) and kebun-talun (annual perennial rotation) cropping systems. In: G.G. Marten (ed.) Traditional agriculture in Southeast Asia: A huma ecology perspective, pp 132-158. Westview Press, Boulder.

Clarke, William C. 1966. From extensive to intensive shifting cultivation: A succession from New Guinea. Ethnology 5: 347-359.

Clarke, William C. 1971. Place and people: An ecology of a New Guinean community. University of California Press, Berkeley.

Cobley, Leslie S. 1976. An Introduction to the botany of tropical crops. Second edition. Longman, London.

Conklin, Harold C. 1957. Hanunoo agriculture. FAO Forestry Development Paper, No 12. FAO, Rome.

Conklin, Harold C. 1963. The study of shifting cultivation. Pan American Union Studies and Monographs VI. Washington, D.C.

Conway, Gordon R. (1985). Agroecosystem analysis. Agricultural Administration 20: 31-55.

COREPASA. 1986. Plan maestro de la Reserva Nacional Pacaya-Samiria. Iquitos Peru.

Crossley D.A.Jr., G.J. House, R.M. Snider, R.J. Snider, B.R. Stinner. 1984. The positive interactions in agroecosystems. In: R.Lowrance, B.R.Stinner and G.J.House (eds.) Agricultural ecosystems: Unifying concepts, pp 73-82. John Wiley and Sons, New York.

Cunard, A.S. 1967 a. Maize agronomy: Part II. World Crops 19(3):24-28.

Cunard, A.S. 1967 b. Maize agronomy: Part IV. World Crops 19(6):45-58.

d'Ans, A.M. 1982. L'Amazonie peruvienne indigene. Payot, Paris.

De Datta, Surijat K. 1981. Principles and practices of rice production. John Wiley & Sons, New York.

de Jong, Wil A. 1984. El sistema de produccion de umari. In: Memoria del taller de trabajo de un plan de investigaciones sobre frutales nativos en la Amazonia Peruana September 1984, Iquitos.

de Jong, Wil A. 1985. Floristiese samenstelling en abundantie van soorten en botaniese families in primair bos en antropogeen beinvloed sekundair bos in de peruviaanse Amazonia. Thesis (MS) Agricultural University, Wageningen.

de Jong, Wil A. 1987. Organizacion de trabajo en la Amazonia Peruana: El caso de las sociedades agricolas de Tamshiyacu. Amazonia Indigena 7(13)11-17.

Denevan, William M. 1971. Campa subsistence in the Gran Pajonal, eastern Peru. Geogr.Rev. 61:496-518.

Denevan, William M. 1976. The aboriginal population of Amazonia. In: W.M.Denevan (ed.) The native population of the Americas in 1492, pp 205-234. University of Wisconsin Press, Madison.

Denevan, William M. 1984. Ecological heterogeneity and horizontal zonation of agriculture in the Amazon floodplain. In: M.Schmink and C.H.Wood (eds.) Frontier expansion in Amazonia, pp 311-336. University of Florida Press, Gainesville.

Denevan, W.M., J.M. Treacy, J.B. Alcorn, C. Padoch, J. Denslow and S. Flores-Paitan. 1984. Indigenous agroforestry in the Peruvian Amazon: Bora Indian management of swidden fields. Interciencia 9(6):346-357.

Denevan, W.M and C. Padoch 1987. Swidden-fallow agroforestry in the Peruvian Amazon. Adv.in Econ.Bot.5.

Dubois, Jean. C.L. 1990. Secondary forests as a land-use resource in frontiere zones of Amazonia. In: A.Anderson (ed.) Alternatives to deforestation: Steps toward sustainable use of the Amazon rainforest, pp 181-229. Columbia University Press, New York.

Ducchart, I., R. Van Haeringen, and F. Steiner. 1990. Introduction: Integrated planning for agroforestry. In: W.W. Budd et al. (eds.) Planning for agroforestry, pp 1-17. Elsevier, Amsterdam.

Duckham, A.N. and G.B. Masefield. 1969. Farming systems of the world. Praeger Publisher, New York.

Dumont, J.F., S. Lamotte and F. Kahn. 1990. Wetland and upland forest ecosystems in Peruvian Amazonia: Plant species diversity in the light of some geological and botanical evidence. For.Ecol.and Manag. 33/34:125-139.

Eden, M.J. 1980. A traditional agro-system in the Amazon region of Colombia. In: J.I. Furtado (ed.) Tropical ecology and development. Proceedings of the Fifth International Symposium of Tropical Ecology, 16-21 April 1979, Kuala Lumpur, Malaysia, Part 1, pp 509-515. The International Society of Tropical Ecology, Kuala Lumpur.

Eden, M.J. and A. Andrade. 1987. Ecological aspects of swidden cultivation among the Andoke and Witoto Indians of the Colombian Amazon. Human Ecology 15(3):339-359.

Eder, James F. 1981. From grain crops to tree crops in the Cuyunon swidden system. In: H. Olofson (ed.) Adaptive strategies and change in Philippine swidden-based societies, pp 91-104. Forest Research Institute College, Laguna Phillipines.

Encarnacion, Filomeno. 1985. Introduccion a la flora y vegetacion de la Amazonia Peruana: Estado actual de los estudios, medio natural y ensayo de una clave de determinacion de las formaciones vegetales en la llanura amazonica. Candollea 40:237-252.

Ewel, John J. 1986. Designing agricultural ecosystems for the humid tropics. Annual Review of Ecology and Systematics, 17: 245-271.

Fernandes E.C.M., A. O'King, and J. Maghembe. 1984. The Chagga homegardens: A multistoreyed agroforestry cropping system on Mount Kilimanjaro (Northern Tanzania). Agroforestry Systems 2:73-86.

Ferrando, Delicia. 1985. Situacion demografica. In: Peña Herrera et al. La selva Peruana: Realidad Poblacional, pp 35-57. Ediciones Anidep, Lima.

Frechione, J., D.A. Posey and L. Francelino da Silva 1989. The perception of ecological zones and natural resources in the Brazilian Amazon: An ethnoecology of lake Coari. In: D.A.Posey and W.Balée (eds.) Resource management in Amazonia: Indigenous and folk strategies. Adv.in Econ.Bot. 7:260-259.

Fresco, Louise O. 1988. Cassave in shifting cultivation. Royal Tropical Institute, Amsterdam.

Gallais, J. et al. 1991. Sahel Nordeste Amazonie: Politiques d'aménagement en milieux fragiles. UNESCO, Paris.

Gasche, Jurge. 1980. El estudio comparativo de los sistemas de cultivo nativos y su impacto sobre el bosque amazonico. In: Consulta scientifica subregional sobre las actividades de corte y quema en el ecosistema de bosque tropical. Man and the Biosphere Program, Iquitos.

Geertz, Clifford. 1963. Agricultural involution: The process of ecological change in Indonesia.

Gely, Anne. 1989. Une réponse stratégique face au risque en agriculture: les systemes agroforestiers de l'estuaire amazonien. In: M.Eldin and P.Milleville (eds.) Le risque en agriculture. ORSTOM, Paris.

Getahun, A. 1990. Agroforestry for development in Kenya: An overview. In: W.W. Budd et al. (eds.) Planning for agroforestry, pp 183-202. Elsevier, Amsterdam.

Gholz, H.L. 1987. Introduction. In: H.L. Gholz (ed.) Agroforestry: Realities, possibilities, and potentials, pp 1-6. Martinus Nijhoff Publishers, Dordrecht.

Gladwin, H. and M. Murtaugh. 1980. The attentive-preattentive distinction in agricultural decision making. In: Peggy Barlett, (ed.) Agricultural decision making: Anthropological contributions to rural development. Academic Press, New York.

Golob, Ann. 1982. The upper Amazon in historical perspective. Dissertation. University Microfilms International, Ann Arbor.

Gonzales Boscan, Valois C. 1987. Los morichales de los llanos orientales. Un enfoque ecologico. Ediciones Corpoven.

Gordon, Burton L. 1969. Anthropogeography and rainforest ecology in Bocas del Toro province, Panama. University of California, Department of Geography, Berkeley.

Gordon, Burton L. 1982. A Panama forest and shore: Natural history and Amerindian culture in Bocas del Toro. The Boxwood Press, Pacific Grove.

Goulding, M. 1980. The fishes and the forest. University of California Press, Berkeley.

Guillaumet J.L. et al. 1990. Les jardins-vergers familiaux d'Amazonies centrale: un example d'utilisation de l'espace. Turrialba 40(1) pp 63-81.

Gupta, P.C. and J.C.O'Toole. 1986. Upland rice: A global perspective. IRRI, Los Baños.

Guyot, M. 1975. Le systeme cultural Bora-Miraña. In: P. Centrelivres, J. Gasché and A. Lourteig (eds.) Culture sur brulis et évolution du milieu forestier en Amazonie du nord-ouest. Musée d'Ethnographie, Switzerland.

Hallé, F., R.A.A. Oldeman, P.B. Tomlinson 1978. Tropical trees and forests: An architectural analysis. Springer Verlag, New York.

Hanks, Lucien M. 1972. Rice and man: Agricultural ecology in Southeast Asia. AHM Publishing Corporation, Arlington Heights, Illinois.

Hardenburg, W.E. 1912. The Putomayo, the devil's paradise. T.Fisher unwin, London.

Harris, D.R. 1971. The ecology of swidden cultivation in in the upper Orinoco rainforest, Venezuela. Geogr. Rev. 61:475-495.

Higbee, Edward C. 1945. The river is the plow. Science Monthly 60:405-416.

Hiraoka, Mario. 1985 a. Floodplain farming in the Peruvian Amazon. Geographical Review of Japan 58(1):1-23.

Hiraoka, Mario. 1985 b. Changing floodplain livelihood patterns in the Peruvian Amazon. Tsukuba Studies in Human Geography IX. Institute of Geoscience. University of Tsukuba.

Hiraoka, Mario. 1986. Zonation of mestizo riverine farming systems in Northeast Peru. National Geographic Research 2(3):354-371.

Hiraoka, Mario. 1989a. Agricultural systems on the floodplains of the Peruvian Amazon. In: J.O.Browder (ed.) Fragil lands of Latin America, pp 75-101. Westview Press, Boulder.

Hiraoka, Mario. 1989b. Ribereños changing economic patterns in the Peruvian Amazon. Journal of Cultural Geography 9(2):103-119.

Hiraoka, Mario. 1992. Caboclo and ribereño resource management in Amazonia: A review. In K. Redford and C. Padoch (eds.) Conservation of Neotropical forests, pp 134-157. Columbia University Press, New York.

Hoekstra, D.A. 1987. Economics in agroforestry. In: J.W. Beer, H.W. Fassbender and J. Heuveldop (eds.) Advances in agroforestry research, pp 36-49. CATIE, Turrialba.

Hopkins, Nicholas S. 1987. Mechanized irrigation in upper Egypt: The role of technology and the state in agriculture. In: B.L. Turner II and S.B. Brush (ed.) Comparative farming systems, pp 223-247. The Guilford Press, New York.

Irion, G. 1984. Sedimentation and sediments of Amazonian rivers and evolution of the Amazonian landscape since Pliocene times. In: Harald Sioli (ed.) The Amazon, pp 201-214. Junk Publishers, Dordrecht.

Irvine, Dominique. 1987. Resource management by the Runa Indians of the Ecuadorian Amazon. Dissertation Dep. of Anthropology, Standford University. University Microfilm International, Ann Arbor.

Irvine, Dominique. 1989. Succession management and resource distribution in an Amazonian rainforest. In: D.A.Posey and W. Balée (eds.) Resource management in Amazonia: Indigenous and folk strategies. Adv.in Econ.Bot. 7:223-238.

Johnson, Allen. 1983. Machiguenga gardens. In: R.B. Vickers and W.T. Vickers (eds.) Adaptive responses of native Amazonians, pp 29-64. Academic Press, New York.

Jordan, C.F. 1981. Nutrient leaching from agro-ecosystems in the Amazon Basin, and implications for recovery of the forest. In: J.I. Furtado (ed.) Tropical ecology and development. Proceedings of the Fifth Internatinal Symposium of Tropical Ecology, 16-21 April 1979, Kuala Lumpur, Malaysia, Part 1, pp 553-561. The International Society of Tropical Ecology, Kuala Lumpur.

Jordan, Carl F. 1989. Shifting cultivation. In: Carl F. Jordan (ed.) Amazonian rainforest: Ecosystem disturbance and recovery, pp 9-23. Springer Verlag, New York.

Junk, W.J. 1970. Investigations on the ecology and production-biology of the "floating meadows" (Paspalo-Echinocloetum) on the middle Amazon. Part I. The floating vegetation and its ecology. Amazonian 2(4):449-495.

Junk, W.J. 1980. Aquatic macrophytes: Ecology and use in Amazonian agriculture. In: J.I. Furtado (ed.) Tropical ecology and development. Proceedings of the Fifth Internatinal Symposium of Tropical Ecology, 16-21 April 1979, Kuala Lumpur, Malaysia. Part 2, pp 763-770. The International Society of Tropical Ecology, Kuala Lumpur.

Junk, W.J. 1984. Ecology of the varzea, floodplain of Amazonian whitewater rivers. In: Harold Sioli, (ed.) The Amazon: Limnology and landscape ecology of a mighty tropical river and its basin, pp 215-244. Junk Publishers, Dordrecht, The Netherlands.

Kahn, F. and K. Mejia. 1990. Palm communities in wetland forest ecosystems of Peruvian Amazonia. For.Ecol.and Manag. 33/34:169-179.

Kalliola, R., J. Salo and Y. Makinen. 1987. Regeneracion natural de selvas en la Amazonia Peruana 1: Dinamica fluvial y succesion ribereña. Memorias del Museo de Historia Natural Javier Prado, No. 18. Universidad Nacional Mayor de San Marcos, Lima.

Kalliola, R., Y. Makinen and S. Salo. 1988. Regeneracion natural de selvas en la Amazonia Peruana 2: Autecologia de algunas especies succesionales. Memoria del Museo de Historia Natural Javier Prado No. 18. Universidad Nacional Mayor de San Marcos, Lima.

Klammer, Gerhard. 1984. The relief of the extra-Andean Amazon basin. In: Harald Sioli (ed.) The Amazon, pp 47-83. Junk Publishers, Dordrecht.

Lageman, J. and J. Heuveldop. 1983. Characterization and evaluation of agroforestry systems: The case of Acosta-Puriscal, Costa Rica. Agroforestry Systems 1: 101-115.

Lamotte, Sandrina. 1990. Fluvial dynamics and succession in the lower Ucayali river basin, Peruvian Amazonia. For.Ecol.and Manag. 33/34:141-156.

Lathrap, Donald. 1970. The upper Amazon. Praeger, New York.

Laur, Pedro nd. Como calcular los costos de produccion. Mimeograph, COPAPMA, Iquitos, Peru.

Leuschner, W.A. and K. Khaleque. 1987. Homestead agroforestry in Bangladesh. Agroforestry systems 5: 139-152.

Lopez Parodi, José. 1982. A peruvian experience for the development of Amazonia: The regional development organization of Loreto (Ordeloreto) and the Jenaro Herrera setllement project. In: S.B. Hecht (ed.) Amazonia: Agriculture and land-use research. CIAT, Cali.

Lopez, J. and D. Freitas. 1990. Geographical aspects of forested wetlands in the lower Ucayali, Peruvian Amazonia. For.Ecol.and Manag. 33/34:157-168.

MacDicken, Kenneth G. 1990. Agroforestry management in the humid tropics. In: K.G. MacDicken and N.T. Vergara (eds.) Agroforestry: Classification and management, pp 98-149. John Wiley & sons, New York.

MacDicken, K.G., and N.T. Vergara. 1990. Introduction to agroforestry. In: K.G. MacDicken and N.T. Vergara (eds.) Agroforestry: Classification and management, pp 1-30. John Wiley & sons, New York.

Marten, G. and D.M. Saltman. 1986. The human ecology perspective. In: G. Marten (ed.) Traditional agriculture in Southeast Asia: A human ecology perspective, pp 20-53. Westview Press, Boulder.

Meggers, Betty J. 1971. Amazonia: Man and culture in a counterfeit paradise. Aldine-Atherton, Chicago.

Meyers, Thomas. 1988. The origen of the Ribereños. Paper presented at the 46th International Congress of Americanists, Amsterdam.

Michon, Genevieve. 1985. De l'homme de la foret au paysan de l'arbre: Agroforesteries indonésiennes. These Académie de Montpellier, Université des Sciences et Techniques du Languedoc.

Michon, G., J. Bompard, C. Ducatillon and P. Hecketsweller. 1983. Tropical forest architectural analysis as applied to agroforests in the humid tropics: The example of traditional village forests in West Java. Agroforestry Systems 1:118-129.

Michon, G., F. Mary and J. Bompard. 1986. Multistoreyed agroforestry garden system in West Sumatra Indonesia. Agroforestry Systems, 4:315-338.

Muleba, N. and H.C. Ezumah. 1985. Optimizing cultural practices for cowpea in Africa. In: S.R. Kingh and K.O Rachie (eds.) Cowpea: Research, production, and utilization, pp 289-295. John Wiley & Sons, New York.

Nair, M.A. and C. Sreedharan (1986). Agroforestry farming systems in the homesteads of Kerala, southern India. Agroforestry Systems 4:339-363.

Nair, P.K.R. 1985. Classification of agroforestry systems. Agroforestry Systems 3:97-128.

Nair, P.K.R. 1989. Ecological aspects of agroforestry. In: P.K.R. Nair (ed.) Agroforestry systems in the tropics, pp 63-86. Kluwer Academic Publishers, Dordrecht.

Nair, P.K.R. 1990. Classification of agroforestry systems. In: K.G. MacDicken and N.T. Vergara (ed.) Agroforestry: Classification and management, pp 31-57. John Wiley & Son, New York.

Nascimiento, C. and A. Homma. 1984. Amazonia: Meio ambiente e tecnologia agricola. EMBRAPA-CPATU, Belem.

National Research Council. 1992. Conserving Biodiversity: A research agenda for development agencies. National Academy Press, Washington, D.C.

Nye, P.H. and D.J. Greenland. 1961. The soil under shifting cultivation. Commonwealth Agricultural Bureau, Reading.

Nye, P.H. and D.J. Greenland. 1964. Changes in the soil after clearing tropical forest. Plant & Soil 21:101-112.

Norgaard, Richard B. 1981. Sociosystems and ecosystems coevolution in the Amazon. Journal of Environmental Economics and Management 8:238-254.

Okafor, J.C and E.C.M. Fernandes. 1987. Compounds of southeastern Nigeria: A predominant agroforestry homegarden system with crops and small livestock. Agroforestry Systems 5:153-168.

ONERN. 1976. Inventario, evaluacion e integracion de los recursos naturales de la zona Iquitos, Nauta, Requena y Colonia Angamos. Oficina Nacional de Evaluacion de Recursos Naturales, Lima.

ONERN. 1977. Use of remote sensing systems evaluating the potential of the aguaje palm tree in the Peruvian jungle. Oficina Nacional de Evaluacion de Recursos Naturales, Lima, Peru.

Padoch, Christine. 1982. Migration and its alternatives among the Iban of Sarawak. Verhandeling van het Koninklijk Instituut voor Taal-,Land- en Volkenkunde 98. Martinus Nijhoff, The Hague.

Padoch, Christine. 1986. The campesinos of Santa Rosa: History and ethnicity in an Amazonian community. Paper presented at the Annual Meeting of the American Anthropological Association, December 1986, Philadelphia.

Padoch, Christine. 1987. The economic importance and marketing of forest and fallow products in the Iquitos region. In: W.M.Denevan and C.Padoch (eds.) Swidden-fallow agroforestry in the Peruvian Amazon. Adv.in Econ.Bot. 5:74-89.

Padoch, Christine. 1988. Aguaje (Mauritia flexuosa L.f.) in the economy of Iquitos, Peru. In: M.Balick (ed.) The palm-tree of life: Biology utilization and conservation. Adv. in Econ. Bot. 6:214-244.

Padoch, Christine. 1992. Marketing of non-timber forest products in Western Amazonia: General observations and research priorities. In: D. Nepstad and S. Schwartzman (eds.) Non-timber products from tropical forests. Adv. in Econ. Bot. 9:43-51.

Padoch, C. and W.de Jong. 1987. Traditional agroforestry practices of native and ribereño farmers in the lowland Peruvian Amazon. In: H.Gholz (ed.) Agroforestry: Realities, possibilities, and potentials, pp 179-194. Martinus Nijhoff, Dordrecht, The Netherlands.

Padoch, C. and W. de Jong. 1989. Production and profit in agroforestry: an example from the Peruvian Amazon. In: J.O.Browder (ed.) Fragil lands of Latin America, pp 102-113. Westview Press, Boulder.

Padoch, C. and W. de Jong. 1990. Santa Rosa: The impact of forest products trade on an Amazonian place and population. In: G.T.Prance and M.Balick (eds.) New directions in the study of plants and people. Adv.in Econ.Bot. 8:151-159.

Padoch, C., J. Chota Inuma, W. de Jong and J. Unruh. 1985. Amazonian agroforestry: A market-oriented system in Peru. Agroforestry Systems 3:47-58.

Parker, Eugene P. 1981. Cultural ecology and change: A caboclo varzea community in the Brazilian Amazon. Dissertation University of colorado at Boulder. University Microfilms International. Ann Arbor, Michigan.

Parker, Eugene P. 1985. The Amazon caboclo: Historical and contemporary perspectives. Studies in Third World Societies, Vol. 32. William and Mary Press, Williamsburg.

Parker, E.P., D. Posey, J. Frechione and F. da Silva L. 1983. Resource exploitation in Amazonia: Ethno-ecological examples from four populations. Annals of Carnegie Museum 52:163-203.

Peters, Charles. 1990. Population ecology and management of forest fruit trees in Peruvian Amazonia. In: Anthony Anderson (ed.) Alternatives to deforestation. Columbia Unviersity Press, New York, pp 86-98.

Peters, C. and A. Vasquez. 1989. Estudios ecologicos de camu-camu (*Myrciaria dubia*): Produccion de frutos en poblaciones naturales. Folia Amazonica 1(1):83-98.

Petrick, Carsten. 1978. The complementary function of floodlands for agricultural utilization: The varzea of the Brazilian Amazon region. Applied Sciences and Development 12:24-46.

Pinedo Vasquez, Miguel. 1986. Conservation and local control of resources in the Peruvian Amazon. Paper presented at the Annual Meeting of the American Anthropological Association, December 1986, Philadelphia.

Pinedo Vasquez, M.; D. Zarin and P. Jipp. 1990. Land-use in the Amazon. Nature 348:397.

Plattner, Steward. 1988. Introduction. In: Steward Plattner (ed.) Economic anthropology, pp 1-20. Stanford University Press.

Posey, Darrel A. 1983. The keepers of the forest. Garden 6(1) pp 18-24.

Posey, Darrel A. 1984. A preliminary report on diversified management of tropical forest by the Kayapo Indians of the Brazilian Amazon. In: G.T. Prance and J. Kallunki (eds.) Adv.in Econ.Bot. 1:112-126.

Posey, Darrel A. 1985. Indigenous management of tropical forest ecosystems: The case of the Kayapo Indians of the Brazilian Amazon. Agroforestry Systems 3:139-158.

Prance, Ghillean T. 1979. Notes on the vegetation of Amazonia III. The terminology of Amazonian forest types subject to innundation. Brittonia 31(1):26-38.

Purseglove, J.W. 1974. Tropical crops: Dicotyledons. Third impression. Longman Group Limited, London.

Purseglove, J.W. 1975. Tropical crops: Monocotyledons. Second impression. Longman Group Limited, London.

Putzer, Hannfrit. 1984. The geological evolution of the Amazon basin and its mineral resources. In: Harald Sioli (ed.) The Amazon, pp15-46. Junk Publishers, Dordrecht.

Rachie, K.O. 1985. Introduction. In: S.R. Kingh and K.O Rachie (eds.) Cowpea: Research, production, and utilization. John Wiley & Sons, New York.

Raintree, J.B. and K. Warner. 1986. Agroforestry pathways for the intensification of shifting cultivation. Agroforestry Systems 4:39-54.

Rao, M.R., C.S. Kamara, F. Kwesiga and B. Duguma. 1991. Agroforestry field experiments: methodological issues for research on improved fallows. Agroforestry Today, 2(4):8-12.

Richards, P.W. 1952. The tropical Rainforest. University Press, Cambridge.

Rocheleau M., Dianne A. 1987. The user perspective and the agroforestry research and action agenda. In: H.L. Gholz (ed.) Agroforestry: Realities, possibilities and potentials, pp 59-88. Martinus Nijhof Publishers, Dordrecht.

Roosevelt, Anne C. 1980. Parmana: Prehistoric maize and manioc subsistence along the Amazon and Orinoco. Academic Press, New York.

Roosevelt, Anne C. 1989. Resource management in Amazonia before the Conquest: Beyond ethnographic projection. In: D.A.Posey and W.Balée (eds.) Resource management in Amazonia: Indigenous and folk strategies. Adv.in Econ.Bot. 7:30-62.

Roseberry, William. 1988. Peasants and the world. In: Steward Plattner (ed.) Economic anthropology, pp 108-126. Stanford University Press.

Ross, Eric B. 1978. The evolution of the Amazon peasantry. Journal of Latin American Studies 10(2):193-218.

Ruddle, Kenneth. 1974. The Yukpa cultivation system: A study of shifting cultivation in Colombia and Venezuela. University of California Press, Berkeley.

Ruthenberg, Hans. 1980. Farming systems in the tropics. Second Edition. Clarendon Press, Oxford.

Salo, J., R. Kalliola, I. Hakkinen, Y. Makinen, P. Niemela, M. Puhakka, P.D. Coley. 1986. River dynamics and the diversity of Amazon lowland forest. Nature 322:254-258.

San Roman, Jesus. 1975. Perfiles historicas de la Amazonia Peruana. Ediciones Paulinas, Lima.

Sanchez, Pedro A. 1973. Soil management under shifting cultivation. In: P.A. Sanchez (ed.) A review of soils research in tropical Latin America, pp 46-67. Tech. Bul. No. 219. Soil Science Department N.C. State University at Realeigh.

Sanchez, Pedro A. 1988. Deforestation reduction initiative: An imperative for world sustainability in the twenty-first century. Paper presented at the Bureau of Science and Technology, US-AID. Washington D.C.

Scherr, S.J. 1990. The diagnosis and design approach to agroforestry project planning and implementation: Examples from Western Kenya. In: W.W. Budd et al. Planning for agroforestry, pp 132-160. Elsevier, Amsterdam.

Shaner, W.W., P.F. Philipp and W.R. Schmehl. 1982. Farming systems research and development. Westview Press Boulder Colorado.

Sioli, Harold (ed.) 1984a. The Amazon: Limnology and landscape ecology of a mighty tropical river and its basin. Junk Publishers, Dordrecht, The Netherlands.

Sioli, Harold. 1984b. The Amazon and its main affluents: Hydrography, morphology of the river courses, and river types. In: Harold Sioli (ed.) The Amazon, pp 127-165. Junk Publishers, Dordrecht, The Netherlands.

Schmink, M. 1985. Sao Felix do Xingu: A caboclo community in transition. In: E.P. Parker (ed.) The Amazon caboclo: Historical and contemporary perspectives, pp 143-166. Study in Third World Societies, Vol 32. William and Mary Press, Williamsburg.

Smith, Nigel J.H. 1982. Rainforest corridors. University of California Press, Berkeley.

Smole, William J. 1976. The Yanoama Indians: A cultural geography. University of Texas Press, Austin.

Soemarwoto, O and I. Soemarwoto. 1984. The Javanese rural ecosystems. In: A.T. Rambo & P.E. Sajise (eds.) An introcution to human ecology research on agricultural systems in southeast Asia, pp 254-287. University of the Philippines, Los Baños.

Soemarwoto, O, I. Soemarwoto, Karyono, E.M. Soekartadireja and A. Ramlan. 1985. The Javanese home garden as an integrated agro-ecosystem. Food and Nutrition Bulletin 7:44-47.

Sombroek, W.G. 1984. Soils of the Amazon region. In: H.Sioli (ed.) The Amazon: Limnology and landscape ecology of a mighty tropical river and its basin, pp 521-536. Junk Publishers, Dordrecht, The Netherlands.

Spencer, J.E. 1966. Shifting cultivation in Southeast Asia. Publications in Geography No.19, University of California Press, Berkeley.

Sternberg, Hildegard O'Reilly. 1975. The Amazon river of Brasil. Geographische Zeitschrift, Beihefte 40.

Stocks, Anthony W. 1981. Los nativos invisibles. Notas sobre la historia y realidad actual de los Cocamilla del Rio Huallaga, Peru. CAAAP, Lima.

ten Have, H. 1982. Production and consumption of rice and the socio-economic importance of rice in the tropics. In: International Crongress of the 12th agricultural machinery exhibition. January 19 & 20, 1982, Amsterdam.

Tripathi, R.S. 1977. Weed promlem: An ecological perspective. Tropical Ecology 18:138-148.

Turner II, B.L. and S.B. Brush (1987). Purpose, classification and organization. In: B.L. Turner II and S.B. Brush (eds.) Comparative farming systems, pp 3-10. University of California, Davis.

van der Poel, P, and H. van Dijk. Household economy and tree growing in upland Central Java. Agroforestry Systems 5:169-184.

Vasquez, Rodolfo. 1990. Plantas utiles de la Amazonia Peruana. Iquitos, Peru.

Vergara, Napoleon T. 1987. Agroforestry: A sustainable land use for fragile ecosystems in the humid tropics. In: H.L. Gholz (ed.) Agroforestry: Realities, possibilities and potentials, pp 7-19. Martinus Nijhoff Publishers, Dordrecht.

Vickers, William T. 1976. Cultural adaptation to Amazonian habitats: The Siona-Secoya of Eastern Ecuador. PhD Thesis. University Microfilms International, Ann Arbor.

Vickers, William T. 1978. Native Amazonian subsistence in diverse habitats: The Siona-Secoya of Ecuador. In: Emilio F. Moran (ed.) Changing agricultural systems in Latin America. Studies in Third World Societies, No 7, Williamsburg.

Wagley, Charles. 1953. Amazon town: A study of man in the tropics. MacMillan, New York.

Weinstein, Barbara. 1983. The Amazon rubberboom: 1850-1920. Standford University Press, Standford.

Wesche, R. 1985. The transformation of rural caboclo society upon integration into Brazil's Amazon frontier: A study of Itacoatiara. In: E.P. Parker (ed.) The Amazon caboclo: Historical and contemporary perspectives, pp 115-142. Study in Third World Societies, Vol. 32. William and Mary Press, Williamsburg.

Wiersum, K. Freerk. 1983. Tree gardening and taungya on Java: Examples of agroforestry techniques in the humid tropics. Agroforestry Systems 1:53-70.

Wiersum, K. Freerk. 1985. Forestry aspects of stabilizing shifting cultivation in Africa. Agricultural University, Wageningen.

Wiersum, K. Freerk. (ed.). 1988. Viewpoints on Agroforestry: Second, renewed edition. Hinkeloord, Agricultural University Wageningen, The Netherlands.

Williams, C.N. 1975. The agronomy of the major tropical crops. Oxford University Press, Kuala Lumpur.

Whitmore, T.C. 1984. Tropical rainforests of the far east. Second edition. Clarendon Press, Oxford.

Withmore, T.C. and G.T. Prance (eds.). 1987. Biogeography and Quaternary history in tropical America. Clarendon Press, Oxford.

Yen, D.E. 1984. Arboriculture in the subsistence of Santa Cruz, Solomon Islands. Economic Botany 28:247-284.

NEDERLANDSE SAMENVATTING

DIVERSITEIT, VARIATIE, EN VERANDERING IN *RIBEREÑO* LANDBOUW EN AGROFORESTRY

De stroombeddingen van de grote rivieren van het Amazone bekken worden in het algemeen aangeduid als *varzea*. Deze varzea wordt gekenmerkt door een gevarieerd landschap van natuurlijke dijken, uiterwaarden, en modder- en zandplaten. Daar de hoogste van de natuurlijke dijken slechts een keer in vele jaren overstromen, is het mogelijk om in deze rivierbeddingen landbouw te bedrijven, en te wonen. De varzea was een belangrijk leefgebied voor de pre-columbiaanse Indiaanse groepen in het Amazone gebied. Deze bevolking maakte gebruik van de rijkdom aan vis en vruchtbare landbouwgrond aanwezig in de varzea. De tegenwoordige inheemse bevolking van de varzea worden aangeduid als *ribereños* in Peru, en als *caboclos* in Brazilie.

Wetenschappers hebben verschillende theorieën geformuleerd betreffende het voorhistorisch en tegenwoordig landgebruik in de varzea. Volgens Ross (1978), is landbouw door de inheemse bevolking in de varzea nagenoeg verdwenen omdat zij, als gevolg van sociale desintegratie, niet de vereiste coordinatie kan opbrengen die het gebruik van deze gecompliceerde omgeving vereist. Meggers (1971) betoogt dat het gebruik van de varzea een sociale orginasatie met personen van hogere status nodig heeft. Roosevelt (1980) stelt dat de voorhistorische, hoger ontwikkelde samenlevingen, die in de varzea woonden voordat de Europeanen er kwamen, zich slechts konden ontwikkelen na de introduktie van maiz, daar dit gewas het mogelijk maakte een voldoende hoeveelheid eiwitten te produceren zodat een talrijkere bevolking gevoed kon worden dan met het alleen eten van *cassave* en vis mogelijk was.

In dit boek wordt de diversiteit, variatie, en verandering in landbouw en agroforestry in Santa Rosa en Yanallpa, twee ribereño dorpen aan de Ucayali rivier in Peru, geanalyseerd. Yanallpa ligt op een natuurlijke dijk, totaal ingesloten in de rivier bedding, terwijl Santa Rosa op *terra firme*, het vaste land waarin de rivier zich een weg heeft gebaand, gelegen is. Ribereños beoefenen een gecompliceerde en vernuftige landbouw, en doen dit als individuele boeren zonder leiders die hun daarbij organiseren. Ribereños verbouwen weliswaar maiz en ook rijst, echter voornamelijk voor de verkoop. Zij zijn echter volledig in staat zichzelf te voeden met vis, cassave, en bananen. Het voorbeeld van ribereño landgebruik in de varzea weerlegt de drie bovengenoemde theorieën, die derhalve herformulering vereisen.

Ribereños zijn de afstammelingen van de oorspronkelijk Indiaanse bevolking van het Peruviaanse Amazone gebied, die als gevolg van de, meestal onvrijwillige, deelname aan verschillende ekonomische aktiviteiten in dit gebied, en vermengingen met personen van andere inheemse groepen en immigranten, een nieuwe sociale en culturele identiteit verworven hebben. Zij leven vooral van landbouw, visvangst, handel, en het verzamelen van bosprodukten. Het varzea landschap waar zij voor het grootste gedeelte hun landbouw bedrijven kent een vescheidenheid aan landvormen. Deze verschillen in hoogte niveau, in de frequentie en mate waarin ze overstromen, en als gevolg daarvan, in bodem type en kwaliteit.

Een nieuw concept, genoemd landbouwtype (*agricultural type)*, is gebruikt om de landbouw diversiteit van ribereños te kunnen beschrijven. Een landbouwtype is gedefinieerd als een unieke combinatie van groeiplaats en gewas, dat specifieke landbouw technieken vereist, een bepaalde aktiviteiten kalender heeft, en bovendien een begrensd gemiddeld produktie niveau, een eigen doel van de opbrengst, en een bepaald type en grootte van risiko heeft. In de twee bestudeerde dorpen werd een totaal van veertien verschillende landbouwtypes aangetroffen. Tien daarvan kwamen in de varzea voor, terwijl vier op terra firme gevonden werden.

Variatie in landbouwstrategieën tussen de boeren van de twee bestudeerde dorpen werd ganalyseerd. De samenstelling van de landbouwtypes van elk bedrijf, en de verandering daarin tussen 1985/1986 en 1989 werd opgenomen. Deze samenstellingen werden gekorreleerd aan verscheidene sociaal-economische variabele kenmerken van de boer en zijn familie. Het bleek dat boeren in Santa Rosa bij voorkeur drie tot vijf landbouwtypes hebben, bestaande uit rijst op de vruchtbare modderplaten, een gemengde cassave akker, en een agroforestry veld op terra firme. De boeren in Yanallpa hebben eveneens bij voorkeur drie tot vijf landbouwtypes. Echter in dit geval bestaan die uit maisvelden, bananenvelden, en een gemengde cassave akker. In de twee dorpen zijn veel boeren die om verschillende redenene van dit patroon afwijken, en het is derhalve niet typisch te noemen voor ribereño landbouw. Een verschil in nadruk op rijst produktie in Santa Rosa, en maiz produktie in Yanallpa, beiden verbouwd voor de verkoop, is het gevolg van verschillende mogelijkheden die het landschap biedt in beide dorpen. Als gevolg van veranderde ecologische omstandigheden, verandering van het sociaal economische klimaat, of omstandigheden in de huishoudelijke sfeer, veranderden de meeste boeren in meerdere of minder mate hun landbouwstrategieën tussen 1985/ 1986 en 1989.

Diversiteit in terra firme agroforestry in Santa Rosa, en varzea agroforestry in Yanallpa werden geanalyseerd. In Santa Rosa heeft dit landbouwtype de vorm van het beheren van bospercelen op land dat eerder voor een ander landbouwtype gebruikt werd. Agroforestry velden verschillen in de samenstelling van beheerde soorten, in de mate waarin de velden onderhouden worden, en in de opbrengst. Varzea agroforestry in Yanallpa heeft een meer permanent karakter, en wordt in hogere mate gekombineerd met de produktie van jaarlijks gewassen, dan in Santa Rosa. In Yanallpa wordt bovendien meer de nadruk gelegd op produktie van niet gedomesticeerde soorten, als gevolg van hun grotere schaarste daarvan in dit dorp dat verderaf gelegen is van primair bos.

Levensoverzicht Wil de Jong

Wil de Jong werd geboren in Velden, Limburg, op 7 februari 1956. In 1975 begon hij zijn studies aan de toen nog genoemde Landbouwhogeschool Wageningen. Na het afronden van het kandidaats programma, aan de vakgroep bosbouw, volgde hij het inhaalprogramma filosofie aan de Katholieke Universiteit Nijmegen. Vervolgens deed hij zijn eerste doctoraal onderzoek naar de mogelijkheden om grovedennenbossen te veranderen in meer gemengde bossen op het landgoed Rozendaal bij Arnhem. In 1982 vertrok hij naar Peru om er praktijk te doen aan de *Universidad Nacional de la Amazonia Peruana*, en deed hij een tweede doctoraal onderzoek naar de floristische samenstelling van secundaire bossen op voormalige akkers van Bora Indianen in het Amazone gebied nabij de Colombiaanse grens. In 1984 werkte hij een jaar aan het *Instituto Nacional de Investigacion Agricola* in Iquitos, in een onderzoek naar *Poraqueiba sericea* agroforestry produktie in Tamshiyacu, een klein dorp aan de Amazone rivier.

In 1985 begon hij het onderzoek naar *ribereño* landbouw en agroforestry aan de Ucayali rivier, het thema van dit boek, in een projekt dat het *Instituto de Investigaciones de la Amazonia Peruana* uitvoerde in samenwerking met het *Institute of Economic Botany* van de *New York Botanical Garden*. In 1988 vertrok hij naar New York om daar te werken aan de voltooiing van zijn proefschrift. In 1992 begon hij als onderzoeks medewerker aan hetzelfde instituut aan een onderzoek naar Dayak bosbeheer in West Kalimantan. Op 1 November 1995 begint hij een nieuwe aangstelling aan het *Centre for International Forestry Research* in Bogor, Indonesie.