//ct//Production and Profit in Agroforestry: An Example from the Peruvian Amazon//xct//

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//h1//Introduction//xh1//

It is becoming increasingly commonplace to suggest that indigenous Amazonian forms of resource use may offer sound models for use of tropical forest lands by non-indigenous peoples. Researchers have succeeded in convincingly demonstrating that tribal peoples have profound and detailed knowledge of agricultural soils, useful plants and animals, and productive agricultural and forestry techniques, that allows them a varied and good diet and abundant subsistence supplies (Boom, 1987; Prance, 1984; Posey, 1982, 1984, 1985; Vickers and Plowman, 1984; Denevan and Padoch, 1988; and many others). However, quantitative data showing traditional practices to be economically attractive alternatives for non-indigenous people are still scant. The production and income figures, as well as data on labor requirements, that would convincingly argue that these resource use patterns can also yield an acceptable living for peoples who need and want market goods are more difficult to find.

Data detailing the commercial value of traditional Amazonian production are often missing because many researchers have chosen to study the few remaining remote groups whose market participation is minimal. The urgency of studying such fast-changing groups is undeniable. However,

the life style of many tribal peoples is very distant from the dreams and realities of non-tribal Amazonians, and their resource use patterns need to be substantially modified if they are to be acceptable to immigrants and others.

The difficulty of collecting reliable production statistics on traditional cultivation systems, particularly on agricultural or agroforestry practices that include a diversity of species and that yield a large variety of products, also accounts for the scarcity of such important data. The quantification of necessary labor inputs is extraordinarily difficult in complex systems. A lack of studies on prices, markets, and marketing in the Amazon Basin contributes as well to the difficulty of realistically assessing the commercial value of resource production by tribal methods.

The recent increased interest in studying the resource use patterns of indigenous or long-resident, non-tribal communities of Amazonia, such as Peru's ribere;atnos (Hiraoka, 1985a, 1985b, 1986; Padoch and de Jong, 1987; Padoch et. al., 1985; de Jong, 1987) or the caboclos of Brazil (Anderson et al., 1986; Parker, 1985) may help fill this significant gap in the discussion of development alternatives for the region. These populations are usually more closely tied with local and even export markets than are tribal groups, and often have needs and expectations that more closely reflect national norms. There still exists little quantitative information on the subsistence and

commercial production of these heretofore poorly studied Amazonians. This article is an effort to add to this small but increasing body of knowledge.

//h1//Resource Use Among Peru's Ribere;atnos//xh1//

The ribere;atnos of Peru have been called the "forgotten Amazonians.'' Considering their demographic predominance in the lowland Peruvian Amazon, and the importance of their environmental knowledge of a greatly varied area, the paucity of studies of these non-tribal peoples is surprising. When they have been noticed, ribere;atnos have often been mistaken for recent immigrants and have been erroneously labelled colonists. Most ribere;atnos are the descendants of detribalized natives and of immigrants who arrived in the Amazonian lowlands of Peru in generations past, many during the great rubber boom of the turn of the century. Many ribere;atno communities are located within the floodplain of the Amazon River or its major tributaries and their agricultural activities include the farming of seasonally inundated lands. A great many ribere;atno villages also make use of //it//terra firme//xit// areas, that is, lands that stand above the river's flood.

A great variety of resource management activities tends to characterize most ribere;atno households (Hiraoka, 1986; Padoch, 1988). These often include the cropping of rice, beans, and cowpeas on annually flooded mudflats and beaches, the growing of a variety of grains, root crops, fruits and

other plants on the relatively fertile natural levees, and the tending of diverse swiddens above the floodplain. However, several recent research projects on both //it//varzea//xit// (seasonally inundated) and //it//terra firme//xit// resource use by ribere;atnos (Padoch and de Jong, 1987; Padoch et.al., 1985; and Brazilian caboclos (Anderson et al., 1986) have focussed not on these more familiar agricultural activities, but specifically on agroforestry systems employed by these populations.

Amazonian agroforestry systems include a diversity of production patterns, ranging from the most subtle manipulation of largely natural forests to increase their economic yields, to the creation and maintenance of near monocultural commercial orchards (Hecht, 1982; Padoch and de Jong, 1987). Many of these systems are cyclic and are based on an alternation of intensively cultivated swiddens and less intensively managed fallows. Such swidden-fallow agroforestry techniques are obviously based on indigenous practices. Tribal forms of swidden-fallow use have been studied in several parts of the Amazon basin including areas in Peru (Denevan and Padoch, 1988), Ecuador (Irvine, 1985), and Brazil (Posey 1982).

Studies we conducted between 1984 and 1987 in the region of Iquitos, Peru, as part of a cooperative program of research between the Instituto de Investigaciones de la Amazonia Peruana and the New York Botanical Garden's Institute of Economic Botany, found that a large number of

variants of swidden-fallow agroforestry are employed by ribereno farmers (Padoch and de Jong, 1987). In this paper we report on agroforestry production in only one village, Santa Rosa.

Coding

//h1//Agroforestry in Santa Rosa//xh1//

The village of Santa Rosa is located on the true right bank of the lower Ucayali River, about 150 kilometers upstream from Iquitos. In 1986 it had a population of slightly over 300 persons. The community is a very complex mix of descendants of several tribal groups (now acculturated), and of families of some European ancestry but with a long history in the region. Few, except the very youngest Santa Rosinos have lived in the community all their lives; the life histories of many include several long migrations and changes of residence (Padoch and de Jong, in press).

The village is quite new. Many of its older residents once worked on a large plantation just a kilometer or two upriver. That enterprise folded about thirty years ago and the community of Santa Rosa was founded a few years later. The location of the village itself has moved several times in the last few decades. The present village site is on //it//terra firme,//xit// although Santa Rosa villagers also farm many lower floodplain areas, including mud-flats and beaches that flood annually, and natural levees that flood periodically. Requena, a town of approximately 10,000

inhabitants is only 20 kilometers up the Ucayali. The town offers a convenient, if rather limited, market for Santa Rosa's produce.

Most Santa Rosa farmers spend less than half their working time cultivating the //it//terra firme//xit// swidden plots that we shall describe here. However, at any time, almost everyone has at least one producing swidden on a //it//terra firme//xit// site, and many maintain agroforestry plots.

All Santa Rosa agroforestry fields are established in largely the same way: swiddens are cut and cleared. The practice of transforming some cut vegetation into charcoal, rather than burning it all in the field (Padoch et. al., 1985), is not unknown, but is rare. The assemblage of annuals and semi perennials first planted into a swidden is a combination of subsistence necessities with some crops destined for the market. Manioc and plantains are most frequently found in such fields, but other annual crops such as rice are often planted, and quickly growing fruits,such as pineapples and cocona (//it//Solanum sessiliflorum//xit//), are very common first year crops.

In some Santa Rosa swiddens planting and maintenance cease after two or three years of intensive annual crop production. These fields are then fallowed, often for a brief period of five to six years, and are then cleared again. However, most farmers in the village choose to turn at least one or two to their swidden fields into agroforestry

plots. When such a decision is made, planting of fruit trees (often a large number of species), usually begins in the first year of swidden production, with more trees planted as the field ages.

In the years following first clearing and planting, both the species produced in the swidden and the management given the field change. Manioc production usually fades quickly after a second annual harvest, and plantains will not produce for long on poor //it//terra firme//xit// soils. The intensive weeding that is given these crops in the first two years usually begins to slack off, becoming less frequent and more cursory in the third year or so. The plants that gradually take over a swidden from the third year onward neither demand nor receive the intensive management that annuals are given. This change in management and production has been interpreted by many previous researchers as "abandonment'' of the field. Although some Santa Rosa fields may indeed be abandoned at this point, many others continue to be managed and to produce economically valuable products.

Some of the early fruiting trees that are interplanted with annual crops may be harvestable in the second or third year after original clearing; other fruits take much longer to produce. By about the fifth or sixth year many swiddens in Santa Rosa have become orchards. For many years thereafter, tree seedlings and even shade-tolerant herbaceous crops may continue to be planted into orchards. To an untrained eye the diversity of species present at this stage

is visually confusing and such fields may easily be mistaken for unmanaged forest.

//h1//Production in Santa Rosa Agroforestry Fields//xh1//

It is difficult to make any but the broadest generalizations about Santa Rosa orchards; both species composition and production are highly variable from one plot to another. Age of the field is an obvious factor in determining what and how much an orchard produces. There are, however, many other important determinants, including the amount and type of management a farmer chooses to employ in the field and his or her own particular choice of species to plant.

In order to determine the production of useful (mostly edible) products in Santa Rosa fields, we both regularly measured the production of useful products in a sample of orchards and asked farmers to keep diaries of their orchards' production. The difficulty of measuring production on highly diverse plots and persuading Santa Rosa residents to maintain accurate diaries over a years' time, allow us to reliably describe only a few of Santa Rosa's many agroforestry plots.

The data presented in Appendix "A'' summarize one year's per hectare production of items with current commercial value in four agroforestry plots in Santa Rosa. These four plots obviously differ very greatly in the species they include and in the level of production that their owners obtain. While none can be said to be typical of Santa Rosa's agroforestry

fields, each represents a stage or type of plot that is repeatedly found---with some variation---in the village and in surrounding communities.

Plot 1 is a managed fallow that was originally cleared and planted many years ago. The precise date of the plot's original establishment is not known to us, but twenty-five years ago is a reasonable estimate. The plot was first cleared by the present owner's father. Many of the larger trees now in the field were planted within the first few years after clearing and several of them are impressively large with diameters of 50 to 75 cm.

Plot 2 is a much younger swidden-fallow. It is only four years old, and intensive management of annuals ceased only about two years ago.

Plot 3 is a somewhat older fallow plot, approximately 6 years since initial felling and contains a slightly different array of plants than the previous example.

Plot 4 is approximately the same age as Plot 3, but the former has been subjected to much less maintenance in the last four years than the latter.

//h1//Diversity of Production in Agroforestry Fields//xh1//

Differences in diversity and level of production among swidden-fallow agroforestry fields in Santa Rosa are quite dramatic. It must be emphasized that the data presented in Appendix "A'' summarize only the per hectare 1986 production of items with some commercial value in the four plots

sampled. Plants that actually yielded products with a significant market value are but a small fraction of all those found in any one of the fields studied. The total number of plant species as well as of all species that yielded useful, but not necessarily commercially important items, in any field is, of course, much higher.

Plot 1, an old, actively managed orchard, produced commercially valuable products of 23 different species. Most of these were fruits, but one tuber species and several construction timbers were also included. It should be also be noted that many of the species included in this plot produced items that are not noted in Appendix "A'' because there is little market demand for them in the region at present. For instance, //it//leche caspi//xit// produces commercially valuable timber, bears an edible fruit, has a latex that is used as a medicine and as a gum for a variety of household needs, and was once an important industrial export of the Peruvian Amazon (Villarejo, 1979; Denevan and Padoch, 1988).

Plot 2, the youngest, was second in diversity of production with commercial materials from 15 species. Plot 3 produced items from 14 different species, and the unmanaged fallow, Plot 4, produced only five different kinds of products.

The differences in diversity among the fields studied can be attributed to many factors. Among the most important factors are the age of the field, the selective clearing and

weeding patterns followed by the farmer, and the amount and type of maintenance work subsequently put into the field. Without a precise history of each plot, it is often difficult to decide exactly which factor weighs most heavily in explaining the specific composition of any field.

Plot 1 with its long history of planting and other management is a very diverse orchard. Most of its production comes from tree species, and it contains very few herbaceous plants when compared with the other plots. However, there are a few non-tree crops in the old field. The owner, although he also maintains some younger swiddens, continues to propagate a few plants such as the tuber daledale, in this old orchard. Plot 2, on the other land, is a young field rich in pineapples, sugar cane, peppers, cocona, and other herbaceous crops.

With age, one can expect that Plot 2 will begin to increasingly resemble Plot 1. However, this will only be the case if maintenance practices, including subsequent planting and selective weeding, of the two plots is similar. Plot 1 is given a slash weeding once or twice a year. The only new plants that are spared in such cleanings are volunteers that grow from seeds of already establish cultigens. Several tropical cedars and some of the individual fruit trees in Plot 1 are not strictly planted, as they result from such natural seeding. However, little or no forest regrowth is allowed to survive the weedings of Plot 1. Plot 4, in contrast, is a field where weeding almost stopped after the

second year. Except for a little protection of plaintains, maintenance work has ceased. Forest regrowth has eliminated several less competitive plants, although some fruit trees, such as the //it//anonas//xit// and //it//Ingas//xit// continue to produce in quantity.

The variety of producing species in the highly diverse Plot 1 is also the result of the owner's long history of planting desirable species in the orchard. The owner is a man who likes plants and likes to see variety in his garden. The presence of some palms, such as the //it//huicungo//xit// and //it//pona//xit// is rather unusual and reflects his pride in this garden's diversity. No two Santa Rosa gardens are likely to incorporate exactly the same species.

Few studies of traditional Amazonian agroforestry have discussed in any but very general terms, the actual or potential commercial output of the systems studied. From those that have (Anderson et al. 1986; Padoch et al., 1985; Hiraoka, 1986) it is obvious that actual and/or potential commercial production in agroforestry plots can be substantial. The agroforestry systems that have been shown to produce commercial products in quantity differ greatly in diversity and mangement.

The market-oriented agroforestry plots we described in the village of Tamshiyacu along the Amazon River (Padoch et. al., 1985), produce substantial quantities of fruit for the market in Iquitos. Most of the fields, however, are very low in diversity; some are near monocultures of umari

(//it//Poraqueiba sericea//xit//). The greater species diversity in the orchards of Santa Rosa may be attributable to the difference in marketing opportunties available to producers in the two communities. The city of Iquitos with its quarter-million inhabitants is quite easily reached from Tamshiyacu. Transport of fruit from Santa Rosa to Iquitos, on the other hand, is difficult, since cargo and passenger boats travel only twice a week and fares and cargo charges are high for local residents. Requena is the usual market for Santa Rosinos. Given the small population of Requena, production of a small quantity of many fruits, rather than specialization in one, is economically advantageous.

//h1//Maintenance and Labor Costs//xh1//

Most discussions of agroforestry systems suggest that low labor expenditure is one of their particularly attractive aspects. However, little exact data on the labor costs of traditional agroforestry patterns is available, largely because of the difficulty of accurately measuring the work done on such diverse systems. Not only is it nearly impossible to assess the time put into the harvesting of a myriad of fruit species, but much of the maintenance of agroforestry fields is done in very short time segments and is often done casually.

Cleaning agroforestry plots, particularly older ones, often takes the form of only slash weeding around a few valuable trees. This operation can be done in a few minutes

and may be quickly forgotten by the farmer. Much harvesting also takes place casually. Picking a few fruits is not perceived nor reported as work.

We attempted to estimate the amount of time farmers spend on their agroforestry plots by enlisting their help in noting their agricultural activities in diaries. The owners of Plots 1 and 2 were among the farmers who participated consistently in the labor survey.

The owner of Plot 1 reported that in 1986 he spent only a total of two and a half days working on this particular agroforestry field (1.75 days were spent in harvesting). The owner of plot 2 reported a more substantial 21 days spent working. Three days were devoted to planting, 13.5 to weeding, and five to harvesting.

We assume that the data cited for Plot 1 is a low estimate. Since the plot is located adjacent to the farmer's house, we believe that much of the work done on the field is carried out in a sporadic, casual fashion. It is interesting to note, however, that the farmer does not perceive the maintenance of the field as a labor-consuming task. The substantially longer time the owner of Plot 2 spends in his field is predictable, as the plot is younger and the larger number of herbaceous crops in the field demand more thorough weeding and closer attention. The labor required is, however, still relatively low when compared with other forms of traditional agriculture in the humid tropics.

//h1//The Market Value of Agroforestry Products//xh1//

The two examples of low labor requirements we cited appear especially impressive when the data presented in Appendix "A'' are translated into the monetary value of production from the two plots. In estimating the commercial value in dollars we used average mid-1987 Iquitos market prices of the items produced in the Santa Rosa plots; in some cases we had to estimate average fruit, tuber, or leaf production per plant. The prices were then converted to U.S. dollars, using the current exchange rate of I/.35 = US$1.

Using this method, we found that if all the items produced in Plot 1 had been marketed at the average prices in Iquitos, the owner of the plot would have realized a gross income of $653 per hectare. The owner of Plot 2 would have obtained gross earnings of $635 per hectare.

These estimates should be treated with great caution; they are presented merely to illustrate our point that agroforestry production can have considerable commercial value in the Peruvian Amazon. In a previous article (Padoch et al, 1985) we described the very substantial market production that is realized from the large orchards in the town of Tamshiyacu. That town, however, may be considered somewhat unusual since it is situated in a favorable location in relation to the major market of Iquitos. Santa Rosa, more typical of Amazonian villages, has no major market within easy reach. The town of Requena offers only limited marketing opportunities.

Commercialization of agroforestry produce, especially fruits, is fraught with difficulty for small Amazonian farmers (Denevan and Padoch, 1988; Padoch and de Jong, 1987): transport facilities are poor and costs high; markets are small and extremely volatile; storage facilities are few and poor, and processing facilities are usually non-existent. Farmers also have notoriously poor knowledge of what is happening in markets since communication facilities are poorly developed.

The difficulty of marketing perishable produce is largely responsible for the fact that only $16/per ha was actually realized by the owner of Plot 1 and $22/ha by the Plot 2 owner; 2.4% and 3.5% of the potential respectively. A good deal of the production was consumed by the household and some went to other residents of the community. The farmers may also have underreported their earnings which include income from the sale of rice and other cash crops and some fish.

//h1//Summary and Conclusions//xh1//

We have presented a small sample of data concerning production of materials with commercial value in some agroforestry fields located in the Amazonian village of Santa Rosa. The fields are different, diverse, and productive. The production, we have suggested, is achieved with a small amount of labor. The potential commercial returns are substantial, but the actual market returns are small.

We believe that the data presented here and elsewhere (Denevan and Padoch, 1988; Padoch and de Jong, 1987; Padoch et al., 1985) have shown that Amazonian agroforesters can produce substantial quantities of commmercial crops, but are constrained by inadequacies of transport, marketing, and export facilities. Much enthusiasm has been expressed for the extension of agroforestry practices and the promotion of the planting of tree crops, including fruits. Those who wish to promote agroforestry, however, should take a broad approach to research and extension, and include in their work a realistic assessment of the problems of marketing in areas such as the Peruvian Amazon.

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