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Amazonian agroforestry: a market-oriented system in Peru

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Abstract. Most reports on indigenous agroforestry systems of the Amazon region have described patterns employed by tribal groups almost exclusively for their own subsistence. This article discusses a market-oriented cyclic agroforestry system practiced by non-tribal 'Mestizo' farmers in Tamshiyacu, Peru. The system produces charcoal, as well as annual, semi-perennial, and perennial crops for local consumption, and for a regional market. The sale of these products provides a substantial cash income for many farmers. The data presented demonstrate that Amazonian cyclic agroforestry systems are capable of being commericially successful enterprises and of serving as possible models for further agricultural development.

Resumen. La mayoria de informes sobre sistemas agroforestales indígenas de la región amazónica han descrito formas utilizadas por grupos nativos casi exclusivamente para su subsistencia. Este artículo trata de un sistema agroforestal cíclico comercial empleado por agricultores mestizos en Tamshiyacu, Perú. Este sistema produce carbón, huertos anuales, semi-perennes y perennes para el consumo local y para el mercado regional. La venta de estos productos da un ingreso considerable a muchos agricultores. Los datos presentados demuestran que sistemas agroforestales amazónicos pueden tener valor comercial y servir de modelos eventuales para el desarrollo agrícola.

Introduction

Traditional agricultural systems, often maligned in the past as destructive, non-productive, and generally 'primitive' are now enjoying considerable interest and respect among many scientists and development workers. Much of this current attention stems from the obvious need to develop environmentally and economically sound agricultural systems for the humid tropics where temperate methods of production have often failed. It is increasingly recognized that traditional patterns offer promising and proven models for development in these difficult environment.

Complex indigenous agroforestry systems have attracted significant attention. The National Research Council (U.S.A.), among other agencies has urged that 'information on traditional agroforestry and food production methods in the region [humid tropics] should be cataloged and evaluated before this valuable empirical knowledge is lost' [7].

Cyclic agroforestry in the Amazon

Among the agricultural forms indigenous to Amazonia that have been described as environmentally sound as well as economically productive are cyclic agroforestry or swidden-fallow management systems. Such methods of agricultural land use involve the cutting and burning of forest or fallow vegetation, followed by the planting of annual and semi-perennial crops. After several months' or a year's growth, the first cropping is followed by the interplanting or successional plantings of perennial crops. Management of the plot changes in intensity throughout the years of use, beginning with intensive cultivation including frequent cleaning, and progressing to increasingly less intensive management, rare and only partial weeding, and eventual regeneration of largely natural growth. Production of the plot obviously changes as well; tree crops replace the roots, grains, and semi-perennial fruits that are harvested in the first several years. Reports indicate that such systems are characterized by considerable diversity of crops, low labor requirements, and protection of soils from deterioration and erosion.

A number of cyclic agroforestry systems as practiced by tribal groups of the Amazon region have been briefly described [1, 3, 4, 10] and a few are now being investigated in depth [2, 8, 9]. These studies have been and are including research into crop inventories, management techniques, composition of natural regrowth, changes in soils, and patterns of use of swidden-fallow resources. However, as the groups studied to date are relatively remote ones, and largely removed from active market trade, the operation of cyclic agroforestry systems as means of obtaining significant cash income has not been adequately examined. The limitation of these studies to isolated, tribal communities has unforunately suggested that such methods of resource use are known only to the most traditional groups and are suited merely for the production of their subsistence needs; as such, these systems would be of little utility as models for agricultural development. More recent investigations carried out by a number of independent researchers, however, indicate that similar systems can indeed be important cash producers.

Market-oriented agroforestry in Peru

The residents of the Peruvian village of Tamshiyacu, located on the true right bank of the Amazon, about 30 kilometers southwest of the regional marketing center of Iquitos (see Figure 1), are neither isolated from market trade nor are they members of tribal communities. Obviously of mixed European and Amazonian ancestry, the approximately 2,000 Tamshiyaquinos engage in a large number of agricultural and extractive activities [5], exploiting the varied land and water resources available to them.

A description of the physical and biotic environment which the residents of Tamshiyacu use, as well as of the processes by which fields of various

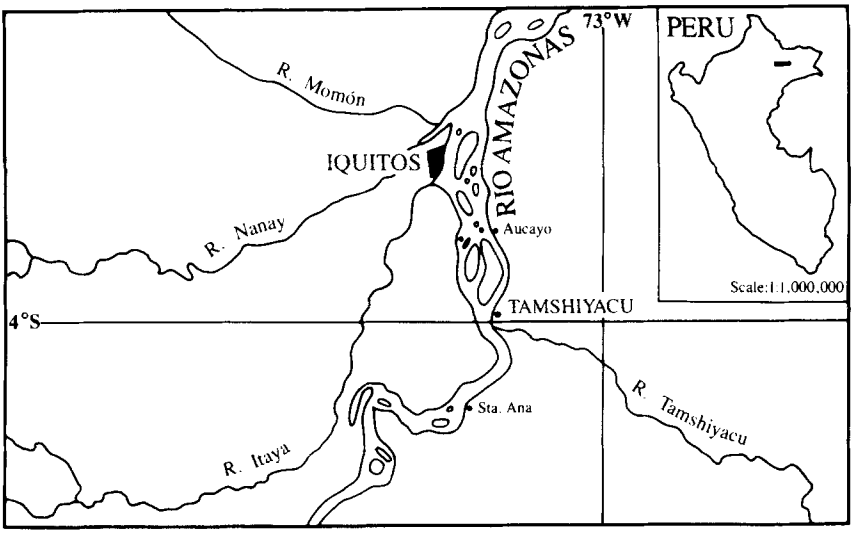

Figure 1. Map of the immediate area of Iquitos, showing the location of Tamshiyacu.

kinds are selected, cleared, planted, managed, and harvested has been provided by Hiraoka [5] who examined the agricultural activities of the village in 1981 and 1982. The resource use techniques employed by Tamshiyaquinos were found by Hiraoka to include the farming of upland sites under both high forest and fallow growth of varying ages, the cultivation of seasonally inundated lowlying sites, as well as fishing, hunting, and the extraction of a variety of forest products. The fields and forests of Tamshiyacu yield foods, fibres, handicraft materials, charcoal, and numerous other items which appear in both an active local market and the urban market in Iquitos.

In late July of 1983, Padoch and Chota visited Tamshiyacu in the course of a broader study of marketing of forest and agricultural products in the Iquitos region [2]. Within a period of a few days we interviewed members of several households concerning their sources of income and the methods of production or extraction they employed to obtain that income. We also visited a number of agricultural fields in both preparatory and productive stages.

In March 1984, Chota and de Jong again visited Tamshiyacu and conducted further interviews. During the two periods of research a total of nineteen households were sampled; in each we interviewed an adult male and/or female member. An attempt was made to obtain a broad spectrum of households known by Chota – a native of Tamshiyacu – to engage in differing principal occupations and to be of differing economic means. A statistically random sample was not obtained. Since villagers keep no written records of most commercial transactions, we had to rely on the recall of our

informants for data on the entire past year's (1982 or 1983) marketing. Both production and prices vary greatly throughout the year, therefore, these data are, of course, subject to considerable error. The sources of income which we found to be important in the community are listed in Table 1, classified according to categories in descending order of their average importance.

As the data indicate, monetary income in Tamshiyacu households is derived from a variety of activities and households differ greatly in the activities from which they derive the major portion of their income. (A more thorough study would probably have shown that an even wider array of income sources including fishing, small vegetable farming, and livestock production are important on a community-wide basis.) An examination of the methods by which the various products mentioned in Table 1 are produced reveals that by far the most significant income-generating activity in Tamshiyacu is the cultivation and harvesting of cyclic agroforestry plots, the source of most marketed products.

Table 1. Major sources of income in Tamshiyacu

	Percentage of annual income	
Product category	Average	Range
1. Cultivated fruits Umari (Poraqueiba sericea) Peach palm, pijuayo (Bactris gasipaes) Star apple, caimito (Chrysophyllum cainito) Uvilla (Pourouma cecropiaefolia) Inga (Inga edulis) Cashew (Anacardium occidentale) Brazil nut (Bertholletia excelsa)	63%	0–100%
2. Intensively managed crops Manioc (Manihot esculenta) Plantain (Musa paradisiaca) Rice (Oryza sativa) Papaya (Carica papaya) Pineapple (Ananas comosus) Cocona (Solanum sessiliflorum) Tumbo (Passiflora mollissima)	21%	0–65%
3. Animal products Meat (deer, peccary), skins	9%	0–86%
4. Charcoal Many tree species	3%	0–37%
5. Forest fibers, handicrafts Chambira fiber hammocks (Astrocaryum chambira) Tamshi fiber, baskets (Heteropsis jenmani)	2%	0–17%
6. Forest fruits, palm heart Aguaje (Mauritia flexuosa) Ungurahui (Jessenia bataua) Huasai, chonta (Euterpe precatoria)	1%	0–13%
7. Medicinal plants Chuchuashi (Maytenus krukovii) Clavohuasca (Mandevilla scabra)	0.5%	0–7%

The Tamshiyacu production system

A rather detailed discussion of the processes by which cyclic agroforestry plots are created and used has been presented by Hiraoka [5], who noted the large number of species planted and the variability of field treatments employed in the area. In Table 2 a generalized picture of only the most important commercial production of agroforestry fields is given, following a widely employed production schedule and using a common assemblage of crops which result in substantial, if not maximum commercial output from a field.

Figure 2. The first planting of a cyclic agroforestry field in Tamshiyacu. Annual and some perennial crops have been planted.

The cycle is initiated when the standing vegetation in an area is cut. Then, if the vegetation was secondary forest, rather than burning all the slash in the manner typical of shifting cultivators, the larger woody vegetation is converted by Tamshiyaquinos to charcoal and sold in the market. Following clearing, the field is planted to a variety of annual and semi-perennial crops, of which the most important commercial ones are mentioned in Table 2. In the second year some of these crops are replanted and a number of perennials, most of them tree crops, are planted. After the initial period of two to five years, annual crop production is gradually phased out and perennial tree crops become the most important income producers from the plot. Such production can often continue for approximately 25 to up to 50 years if

Figure 3. Middle stage of production in a cyclic agroforestry field. Perennial crops have replaced annuals.

care is taken to maintain the fields and to protect them from the depredations of invading cattle. Cleaning of the plot, done several times a year while annuals and semi-perennials predominate, is gradually reduced in frequency to once or perhaps twice a year, just before umari, the most important tree crop, is to be harvested. As soon as the production begins to fall significantly, anytime between the twenty-fifth and fiftieth year, the larger vegetation – mostly umari and Brazil nut trees – is cut and converted to charcoal. Following this second round of charcoal making, the field is generally fallowed for six years or so, during which time secondary growth invades the plot and, according to local farmers, begins to restore it so another production cycle can begin.

It should be noted that not every field made by Tamshiyaquinos is treated in the fashion described above and outlined in Table 2 [5]. In some instances charcoal is not made from the slash cut in initial clearing of a plot. Also, some fields planted to annuals and semi-perennials are never converted into 'fruit orchards', but are allowed to return to natural growth after only a few years of use.

Table 2 presents estimated production figures for major commercial crops grown in a one hectare plot made in six to seven years' fallow growth. The data show that the important products of cyclic agroforestry plots in Tamshiyacu include charcoal, intensively managed crops, and cultivated fruits. Of these categories of commercial products, virtually all cultivated

Table 2. Estimate of commercial production on one hectare of land

Year of land use	1	2	3	4	5	6	7	8–11	12–20	21–24	25
Annual production (Major commercial products)											
Charcoal (15 kg sacks)	500										600
Manioc (50 kg sacks)	60	5									
Pineapple (fruits, 100's)	5	15	15	30							
Plantains (20 kg racimes)	10	5									
Cocona (30 kg sacks)	5	5									
Cashew (fruits, 100's)	50	50	4								
Uvilla (1.5 kg bunches)		250	1000	100	5						
Peach palm (8 kg racimes)			60	120	80	40	40	40			
Umari (fruits, 100's)				100	200	300	400	600	600	400	
Brazil nuts (fruits, 100's)									5	5	

fruit production, the most important contributor to local budgets (see Table 1), comes from these fields. Much of the harvest of intensively cultivated crops (other than rice) also comes from these plots, as does a very significant portion of the charcoal that is sold in the urban market. It may be noted that the charcoal made at the end of the cultivation period, from umari and Brazil nut trees, is considered to be of particularly high quality.

Other products of agroforestry fields

Apart from a significant volume of production of annual crops, cultivated fruits, and charcoal shown in Table 2, agroforestry plots are often the source of other categories of products.

Our class of 'forest fruits' includes species that are largely spontaneously occurring although since some of the plants included in the category – particularly aguaje and ungurahui – are occasionally planted, the origin of specific trees is often unclear. When economically valuable tree species are encountered in areas to be cleared for fields they are often protected from felling and firing and thus become an integral part of the cultivated plot. Therefore a 'forest fruit' tree is often to be found in a producing agroforestry plot and its production could thus be added to the total for that field. However, we have no estimates for production of forest fruits from agroforestry plots to add to the general totals.

Animal products, chiefly meat and skins sold to Iquitos merchants, are important contributors to the budgets of a number of Tamshiyacu households. In some cases these materials may also be regarded as products of agroforestry fields. Many researchers have noted [2,5,6,8,9] that agricultural fields, particularly those in the later years of production are often prime hunting sites. When fruits are ripe, hunters will frequently build platforms near older fruit trees and watch for animals coming to feed. While we have no specific information to cite concerning the contribution of these plots to animal sales, and hence to household budgets, further study might indeed show that Tamshiyacu's agroforestry fields yield significant income in the form of animal as well as plant products.

Economic importance of agroforestry in Tamshiyacu

Of the seven categories of commercial products important to Tamshiyacu which we distinguished in Table 1, five tend to be harvested completely or partially from agroforestry plots. As Hiraoka mentions, and as we observed, most households have several agroforestry fields in operation at any time. Since these fields are usually in different stages of the production cycle, farmers tend to obtain an income from the sale of a variety of resources. This strategy limits the risks inherent in specialization, spaces out the need for often scarce labor, and assures the households of some cash flow throughout the year.

Figure 4. Fruit collectors during the harvest in a mature *umaral*, an almost pure stand of umari with a few Brazil nut trees.

According to our limited observations, not only does the cyclic agroforestry production method described provide Tamshiyaquinos with a reasonably steady income, it also allows many of them to enjoy some of the highest average annual incomes to be found among rural dwellers of the region. In our survey of thirteen villages in the Iquitos region, we found the average annual household income in Tamshiyacu to be higher or equal to that found in any other village. We estimated that some Tamshiyacu households obtained gross yearly incomes of close to US$ 5,000, although the mean for village households was a much more modest but still above average income of about US$ 1,200. Only one other village in our sample, one where commercial production of pineapples is carried on a large scale, rivalled Tamshiyacu in average income levels. In other communities many farmers who, aided by government loans had successfully moved into commercial rice production, had incomes well below those of Tamshiyacu's more successful agroforesters. Further research into matters such as the relative costs of production including labor necessary in various types of cultivation now being practiced is obviously indicated before any reliable conclusions can be made. (Preliminary data gathered by Chota and de Jong on costs of gathering and bringing fruits to market indicate that up to 40% of the gross income from the sale of fruits may be paid to workers by households poor in labor.) However, the economic viability of Tamshiyacu's agroforestry system appears indisputable.

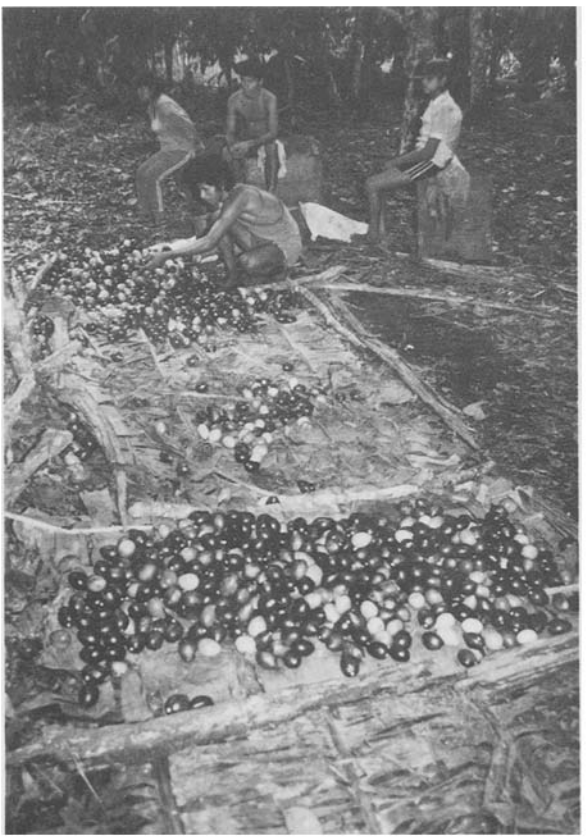

Figure 5. Collectors of umari sorting the fruits prior to sale.

Summary and conclusions

The data presented above have described a cyclic agroforestry system which bears close resemblance to and is obviously developed from the swidden-fallow agroforestry techniques employed by tribal groups throughout the Amazonian lowlands. This system differs from these traditional models in a number of important ways. Notably, some of the vegetation that is normally 'slashed and burned' is, in the Tamshiyacu system, converted to charcoal and removed. Cleaning of the plot is continued for a longer period of time than appears to be typical among the traditional tribal groups previously described, and the creation and maintenance of an almost pure stand of umari and Brazil nut trees during most of the use cycle contrasts with the very complex older swidden-fallow fields found by Denevan and others. Most notable however, is the commercial orientation of the system and the large cash returns households realize from sales of the products. Amazonian cyclic agroforestry

systems are obviously capable of being commercially successful enterprises, in addition to serving as sources of local household needs.

The fact that the Tamshiyacu system is practiced by a group of Amazonian residents who are not traditional tribal peoples, but rather than the 'ribereños' or 'mestizos' whose subsistence technologies have generally been ignored if not severely criticized and condemned, also marks this as an important resource use system. Further research on other relatively neglected 'mestizo' or non-tribal communities, which often include many long-term and environmentally knowledgable residents of the lowlands would doubtless yield other interesting examples of cyclic agroforestry systems.

The desirability and possibility of extending market oriented agroforestry systems similar to that found in Tamshiyacu, to other communities of the Peruvian Amazon and elsewhere in the humid tropics must depend on further research. The long-term sustainability of these production techniques, including their effects on soils has, for instance, not yet been examined. The economics of production and marketing need also to be investigated in depth.

One major constraint on extending this type of production system is the lack of cheap and reliable transportation facilities throughout much of the Amazon. The majority of communities in lowland Peru would have great difficulty in moving products such as those important in Tamshiyacu – largely perishable fruits – to a market within a few days of harvest. Tamshiyaquinos are fortunate in the relatively easy access to the large and busy urban market at Iquitos that they enjoy. Until transportation facilities are improved in the Peruvian Amazon and similar areas of the lowland tropics, or until markets, storage, and processing facilities are developed and decentralized, the market oriented fruit production system described above will be appropriate for only a very limited number of villages. The possibilities of substituting products that are easily stored and thus do not demand immediate sale is another area of research that should be explored before a program of dissemination of such production methods can be pursued.

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References

1. Denevan WM (1971) Campa subsistence in the Gran Pajonal, eastern Peru. The Geographical Review 61:496–518
2. Denevan WM, Flores Paitan S and Padoch C (1984) Indigenous Agroforestry in the Northeast Peruvian Amazon. Project report, Consortium for the Study of Man's Relationship to his Global Environment
3. Eden MJ (1980) A traditional agro-ecosystem in the Amazon region of Colombia. In: Furtado JI, ed, Tropical ecology and development. Proc 5th Int Symp Tropic Ecol, Kuala Lumpur. Vol 1:509–514
4. Harris DR (1971) The ecology of swidden cultivation in the upper Orinoco rain forest, Venezuela. The Geographical Review 61:475–495
5. Hiraoka M (1982) The concept of horizontal and vertical resource use in shifting cultivation: the case of Tamshiyacu, Peruvian Amazon. Paper presented at the meeting of the Conference of Latin Americanist Geographers, Santo Domingo, 1982
6. Linares OF (1976) 'Garden hunting' in the American tropics. Human Ecology 4:331–349
7. National Research Council (1982) Ecological aspects of development in the humid tropics. Washington, DC, National Academy Press
8. Posey DA (1982) The keepers of the forest. Garden 6(1):18–24
9. Posey DA (1983) Indigenous ecological knowledge and development of the Amazon. In: Moran E, ed, The dilemma of Amazonian development. pp 225–257. Boulder, Westview Press
10. Smole WJ (1976) The Yanoama Indians: a cultural geography. Austin, University of Texas Press