RESEARCH IN ECONOMIC ANTHROPOLOGY

Editor: BARRY L. ISAAC
Department of Anthropology
University of Cincinnati

VOLUME 18 • 1997

JAI PRESS INC.

Greenwich, Connecticut *London, England*

FROM EXTRACTIVISTS TO FOREST FARMERS: CHANGING CONCEPTS OF CABOCLO AGROFORESTRY IN THE AMAZON ESTUARY

Eduardo S. Brondízio and Andréa D. Siqueira

INTRODUCTION

Amazonian *caboclos*—the largest native, non-Indian population of the Brazilian Amazon—living in the floodplain have been historically the major contributors to the regional agricultural and forest economy. As population grows in urban centers, their role and that of the fertile floodplain tend to increase. This paper focuses on the production system of açaí fruit (*Euterpe oleracea* Mart.), based on the estuarine floodplain environment, that has become the main economic activity for a large number of towns. Açaí is the vernacular name given to a multi-stem palm, the individual plant of which forms a clump, that occurs naturally in the floodplain areas of the eastern Amazon region. The abundance of açaí in floodplain forest, together with its multi-stem regeneration capacity, makes it a species highly suitable for management. Various management and planting practices transform these

Research in Economic Anthropology, Volume 18, pages 233-279.

ISBN: 0-7623-0273-9

floodplain forests into açaí agroforestry, locally called *açaizais*. Açaí fruit, after being manually or mechanically processed into a thick juice, is a highly appreciated regional staple food in rural and urban areas alike. In rural areas, it is the second most important caloric source, behind manioc flour (Siqueira & Murrieta n.d.). In addition, açaí palm provides the so-called heart of palm, or *palmito*, a delicacy used in salads, soups, and pies, which is one of the main export products of the Amazon estuary.

Despite its importance, the açaí fruit production system is generally regarded as mere extractivism, and it has been treated as such in national socioeconomic surveys, by the regional population, and by scholars (see, e.g., Lima 1956, Calzavara 1972, FIBGE 1974-1989).[1] This assessment is not only a result of the region's socioeconomic history of export-oriented extractivism and outside control of resources, but also a consequence of the way agricultural intensification has been defined. The rigid boundary drawn between different food production systems has placed forested areas (as in the case of agroforestry systems) in the "unproductive" or, at best, the "extractive" category. Agricultural intensification, conventionally defined, is synonymous with deforestation and also implies the ability to keep a place deforested over time. This paper discusses the application of intensification parameters to a food production system, açaí agroforestry, that maintains intensive, long-term staple food production in forested areas with simple, locally developed technological inputs.

Although the literature contains much criticism of the way agriculture intensification has been defined and applied, there have been few attempts to translate that criticism into rural development policies and agricultural practices on the ground. The term "intensification" is frequently applied to factors of production, such as energy and capital inputs, rather than to land use in general (Netting 1993). Thus, classical accounts of intensification have a tendency to quantify it as proportional to increases in energy, technology, and capital input to a given area. That focus tends to overlook the maintenance of output over time and its relationship to other land uses and socioeconomic facets of agriculture. The approach leads to emphasis on the replacement of local land use strategies by external technology based on energy- and capital-intensive systems primarily focused on export-oriented agriculture. Within that framework, the tendency is to neglect investment in existing socioeconomic and physical infrastructure that would enhance local production systems, without threatening the local resource basis, and consequently, economic and food security. In the sustainable development agenda, which has agriculture at its core, intensification has been an elusive concept, an offspring of modernization thought contradictory to productivity, efficiency, sustainability, and adaptability of agricultural systems (Netting 1993).

This paper is organized into three main parts. The first is a literature review of its main topics: agriculture intensification and the co-development of the caboclo's agricultural system and the extractivist economy. This first part concludes with an analysis of the spatial dimensions of land use in the accounts of agriculture intensification and sustainability. In the second part, data from a study site in the Amazon estuary are used to exemplify the socioeconomic structure, management, production, and mapping of açaí agroforestry. Two sets of data are used. The first concerns 12 sites where agroforestry and vegetation inventories were carried out to measure how management changes vegetation structure and composition; the second set comes from eight sites used as experimental agroforestry areas during the harvesting season (between August 1994 and January 1995) to measure production of açaí fruit at the levels of stem, clump, and the whole agroforestry area. The third part of the paper presents, in the light of study area's data, a discussion of the suitability of using conventional intensification measures to account for intensification in agroforestry systems, such as that of açaí. The paper concludes with a review of the extractivism stigma carried by caboclos and how a revision of the agriculture intensification concept, based on the example of açaí agroforestry, can help to build an identity as rural producers.

CONCEPTUAL AND HISTORICAL BACKGROUND

Agricultural Intensification

The most cited reference on agriculture intensification is *The Conditions to Agricultural Growth*, by Ester Boserup (1965). Her seminal work brought an alternative viewpoint to the relationship between population growth and food production, one that questioned the traditional, classical-economic approach to agriculture based on the Malthusian paradigm. While Malthusian advocates had regarded population growth as the dependent variable in relation to food production, Boserup did the opposite. Her model defined population growth as the independent variable that induces intensification and increases food production. Her model contradicted the classical definition, which separated agricultural land into productive and nonproductive categories. In contrast, she (Boserup 1965:13) proposed a model based on "the frequency with which the land is cropped," portraying agriculture as dynamic and related to a broader array of land use activities and landscape changes. Boserup's model, which related intensity to frequency of cultivation, proposed five progressive categories of intensification: (1) Forest-Fallow (20-25-year cycle), (2) Bush-Fallow (6-10 years), (3) Short-Fallow (1-2 years), (4) Annual Cropping (yearly), and (5) Multi-cropping (sequential). As a general model, hers is relatively environmentally, technologically, and socioeconomically "free," allowing for the elasticity, manageability, and variability of human societies, providing a more optimistic view than that of the Malthusians about human adaptive capacity to population growth and environmental limitations. In this sense, for instance, soil does not have a "given" fertility, but instead is manageable, depending on labor input. Nevertheless, although Boserup's work is a powerful heuristic tool for framing general agricultural change, problems emerge when it is applied to particular socioeconomic systems.

Two years before the publication of Boserup's work, Geertz (1963) published another important work on agricultural intensification, namely, *Agricultural Involution*, about the intensification of rice production in Indonesia. In addition to his important contribution to cultural ecology and his seminal use of the ecosystem concept in anthropology, Geertz related agricultural change to a broader array of historical and political explanations. A bit earlier, Brookfield's (1962) studies of New Guinea agriculture used a more traditional economic view of intensification, categorizing it in accordance with quality and quantity of input, such as capital, technology, and labor, instead of processes of change.

These three works are the basis for most of the theoretical debates on agricultural change that emerged during the following decades, but certain other publications are also essential to an understanding of the issues. First, Conklin's (1957) *Hanunoo Agriculture* defined a new phase in the studies of traditional swidden agriculturalists. He changed the simplistic view of swidden agriculture by showing the complexity and diversity of crop association and the efficiency of labor input and output yield in these systems. Second, and contemporary to Brookfield, Geertz, and Boserup, is Netting's (1963, 1965) work among the Kofyar of Nigeria, showing the efficiency of their intercropping/intensification techniques. Although Netting used a framework analogous to Boserup's population-intensification, he shifted from her very general scale to a local level approach that incorporated farm and household into the analysis. Third, with regard to Amazonian agriculture, Carneiro's (1960) work on slash-and-burn agriculture among Kuikuru Indians challenged the environmental determinism argument (mainly about low soil fertility) commonly used to explain the low density of Amazonian populations and the supposedly low productivity of their agricultural system (Meggers 1954). Finally, the work of Nye and Greenland (1960) on the relationship between soil and shifting agriculture provided a scientific basis for understanding the efficiency of swidden agriculture and its impact on soils.

A series of important works testing Boserup's hypothesis have followed. For instance, Clarke (1966) compared four communities in the process of intensification in highland New Guinea. His work supported Boserup's argument and stressed that shifting cultivation is a dynamic land use system with a flexible productive capacity. In addition, his work called attention to the often overly rigid boundaries drawn between swidden and sedentary agriculture, and the tendency to view agricultural growth as a pathway to sedentarism, not to food security. In a later work, Clarke (1976) pointed out the importance of enhancing traditional agriculture by incorporating modern methods but without dismissing local knowledge and technology. He recognized the value of crop diversity and also the possibility of incorporating livestock and tree crops to enhance traditional land use systems. Turner et al. (1977) used regression analysis to test Boserup's model of population pressure and agricultural intensification. Although their results supported Boserup's theory, they found that environmental and subsistence variables needed to be incorporated to improve explanations of agricultural intensification, as earlier proposed by Brookfield (1962). However, the correlation they found was based on data from populations not fully integrated to marketing activities, thus making it difficult to apply their explanations to most small farmers, to whom agricultural decisions are based on market demand. A year later, Turner and Doolitte (1978) proposed a new method for defining and measuring agricultural intensification. They emphasized an ongoing argument that intensification should be measured in terms of production output (yield/area/time). Their model integrates both Boserup (increased frequency of cultivation) and Brookfield (increased technology) as correlated to intensification and defines agricultural intensification as a result of output responding to input.

Closely related to intensification is the carrying capacity concept. Although this concept emerged from animal ecology, one can find its origins in Malthus' theory of population-food balance. Brush (1975) reviewed the concept in the light of shifting agricultural systems, comparing four "formulas" as used by Allan (1949), Carneiro (1960), Conklin (1959), and Gourou (1966). Among the problems he found were the lack of inclusion of other resources important in demographic formulations (e.g., fish and game in Amazonia), assumptions about a limited pool of resources, few considerations of the role of technology, overuse of homeostasis/equilibrium notions, and the difficulty of defining and correlating variables related to the population-land balance. These problems aside, the concept may nevertheless be used advantageously as a descriptive or heuristic device to explain agricultural intensification in relation to land use change.

Vasey (1979) proposed a different reading of agricultural intensification in the humid tropics. His review of the Boserup, Geertz, and Brookfield models suggested that "agriculture intensification in the humid tropics can best be encompassed not by a general model of stages but by the recognition of ecologically optimal strategies at different population densities" (Varsey 1979:280). Likewise, he called attention to the importance of incorporating historical processes, the growth of urban markets, and the role of modern technology to better explain contemporary agricultural intensification in the humid tropics. Of equal importance in his work is the reappraisal of the secondary succession regrowth stages (i.e., fallow cycles) proposed by Boserup (1965). She dismissed the relationship between land use strategies and regrowth, and overlooked the great regrowth capacity of secondary vegetation in the tropics. Furthermore, Boserup's proposed "grass-fallow system," as an advanced stage of intensification, does not take into account the disadvantages of such a system in terms of instability, low productivity, grass competition, and exhaustion and acidity of soils.

The revision of the role of fallows as a productive part of swidden systems has been of particular importance to understanding tropical agriculture. The pioneering studies carried out among the Bora Indians of Peru (see Denevan & Padoch 1987) have revised the idea of fallows as abandoned and unproductive fields. In swidden systems, fallows assume important roles in supplying raw materials, food, and market products, besides their environmental and physical significance.

The basis provided by these and other studies concerning the use of fallows in tropical agriculture (e.g., Anderson & Posey 1989) has added a new dimension to the categorization of stages of intensification of traditional cultivation systems and to the understanding of so-called hidden harvesting.

Assessment of the productivity of swidden cultivation also underwent important revisions during the 1980s. The best example is the *Human Ecology* special issue (1983) entitled *Does the Swidden Ape the Jungle?* In the light of various studies in tropical areas, the general view of swidden gardens as involving highly diversified crops was challenged. These studies show that this system favors the development of monocropping gardens, which are, however, of a polivarieties type. Instead of an intercropping of species, the dominance of a single but polivariety crop tends to increase yield, while decreasing, for instance, the risk of loss due to pest infestation. The authors call attention to the significance of such a system for tropical agriculture in economic, technical, and theoretical terms (Beckerman 1983, Boster 1983, Hames 1983, Stocks 1983).

Five other works may be singled out to represent general aspects of intensification studies in the 1980s. First, Wilken's *Good Farmers* (1987) provided a better understanding of the complexity of traditional agriculture and resource management practices in Mexico and Central America. He called attention to the degree of specialization developed by small farmers to cope with environmental and socioeconomic limitations of areas that sometimes are considered inappropriate for agriculture.

Second, McGrath (1987) reviewed the role of biomass in shifting cultivation, challenging the traditional view of this system as highly productive in terms of energy input/output ratio. If the energy input of biomass burning is considered, shifting cultivation becomes, rather, an energy-inefficient system. Thus, he questioned the use of length of fallow rather than vegetation-soil complex as the best measure to analyze energy input and intensification in this system.

Third, Guillet's studies of the Central Andes of Peru added other amendments to Boserup's model. He showed that "both intensification and deintensification of production can occur simultaneously at the regional or even the community level" (Guillet 1987:201), noting the importance of considering the coexistence of agriculture strategies within a broad scope of land use.

The fourth and fifth of these works point out the emergence of two interdisciplinary approaches, identified as Farming System Research (Turner & Brush 1987) and agroecology (Altieri & Hecht 1990). Both agendas went beyond the development of an interdisciplinary and comparative method, with emphasis at the micro- and meso-scales, to include agriculture change in the context of socioeconomic and ecological changes. While FSR tends to focus on technology, agroecological studies tend to target the understanding of ecological relationships within agricultural systems. In both cases, however, agricultural studies are broadened by a scheme that considers production and technology types, as well as intensity measures with emphasis on yield and ecological sustainability.

New Paradigms of Agricultural Intensification

The last few years of agricultural intensification research may be summarized under two main headings, both related to a broader discussion of the so-called sustainable development and global change agendas: (1) intensification analysis based on small-farm agriculture and resource management, and (2) land use analysis that places agriculture within a broader spatial and temporal landscape context, proposing nested scales of analysis at the local, regional, and global levels.

The best example of the first trend is the outstanding effort by Netting (1993) in evaluating and highlighting the importance and efficiency of small farmer intensive agriculture. Netting's book not only redefined intensification in the light of sustainability and productivity, but also criticized the myth of small-farm unproductivity and backwardness, a connotation historically associated with peasant agriculture. According to him (Netting 1993:262),

> Defining intensive agriculture in terms of yields per unit of land over time emphasizes output as the dependent variable, and it does not prejudge the effect of economic inputs of labor, capital, or technological change. Increases in these independent variables, singly or in combination, on a constant land area, may intensify its use..., but this must be demonstrated by the analysis rather than assumed.

He pointed out that the disruption of small farmer agriculture in favor of modern, energy-intensive technology has recurrently deintensified agriculture and has promoted more extensive forms of land use.

The second important trend of agricultural studies emerging in the 1990s, specified above, is a result of research that integrates approaches and methods of ecological and economic anthropology and land use/landscape ecology. There are two main reasons for this development. On the one hand, ecologically- and economically-oriented anthropologists have scaled up their local unit of analysis, due to the need to understand agriculture and economics at a broader, regional scale (Moran et al. 1994a, Brondízio et al. 1994, NASA 1990, Behrens et al. 1994). On the other hand, ecological and physical scientists working at a global scale have perceived the need to scale down in order to understand the impact of local land use strategies in regional-scale processes (Dale et al. 1993, NRC 1992, Ojima et al. 1994, Skole et al. 1994, Kummer & Turner 1994).

Various unifying interests have contributed to this process of integration. For instance, the increased demand for food in less developed countries, the effects of deforestation upon global biogeochemical and hydrological cycles, and the loss of biological and crop diversity are a result of a model of agricultural expansion based on energy-intensive, export-oriented production systems. By showing the contrast between the complexity and efficiency of local land use strategies and the impact of conventional agriculture and cattle ranching, social and ecological scientists have been the main critics of such development approaches. In this process, the tools of analysis have also changed. Site-specific measures of agricultural activity have been used in conjunction with remotely sensed data and Geographical Information Systems, making possible the extrapolation of spatial and temporal scales. In this research agenda, the dimensions of agricultural change tend to assume a more complex hue. Rates of fallow regrowth and frequency of cropping, such as those proposed by Boserup (1965), can be tested, as can the environmental impact and sustainability of production systems. As Behrens et al. (1994:280) stated, "[B]y mapping processes of human disturbance onto a landscape, translating them to the spatial domain, it becomes possible to derive quantitative measures of intensity and diversity." However, the ability to shift levels of analysis depends on the ability to translate information across scales with minimum loss of detail, a condition that can be achieved only through interdisciplinary research and methods.

Defining Agroforestry

Agroforestry has evolved as a conceptual field in agriculture and forestry over the last 30 years as an alternative response to rural development problems. As an agricultural practice, however, it has been carried out worldwide for centuries, encompassing a countless variety of systems ranging from swidden-fallow to silvopastoral activities. In a global inventory carried out by ICRAF (International Research Center for Agroforestry) in 1987 (Nair 1990), more than 150 different agroforestry systems were registered, including traditional and newly developed systems (also see Gholz 1987). A practical definition encompassing the large variety of agroforestry systems is proposed by ICRAF (1983:33):

> Agroforestry is a collective name for all land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are incorporated on the same land unit as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence....An agroforestry system integrates both ecological and socioeconomical components...an interface between forestry and agriculture.

Caboclo Agriculture: Coping With an Extractivist History

In the previous section, we discussed the flaws of agricultural intensification theories with regard to small-scale agriculture and agroforestry. We now look at the issue of agricultural intensification from the caboclo's social and historical perspective. Attention is paid to the historical development of the caboclo cultural system, the sociocultural categorization of caboclos, and the historical relationship between extractivism and caboclo agriculture.

The term "caboclo" in the Brazilian Amazon context incorporates several distinctive meanings. As used by anthropologists and other social scientists, and in this paper, it incorporates the idea of a social category which originated from detribalization, depopulation, and miscegenation by Portuguese, Africans, and their descendent with the Indians who inhabited the Amazon floodplain between the 16th and 18th centuries, and the later assimilation of northeastern Brazilian migrants to the region in late 19th and early 20th century during the rubber boom (Moran 1974, Parker 1985). In contrast, colloquial usage of the term is loaded with prejudice, since it refers to the rural lower class, a terminology that represents a stigma rather than a categorization (Wagley 1953, Ayres 1992, Nugent 1993). In addition, its colloquial use is a synonym for laziness and lack of "entrepreneur mentality." Caboclo material poverty is often explained as the product of resistance to socioeconomic integration into a wider society, to avoidance of external and new ideas, and even to their origin as "mixed bloods." As a social category, they are seen as "doomed," in need of being changed, "opened up," or "modernized" in order to be incorporated into a market economy; or as a group who will "inevitably" disappear with the development of capitalism. The lack of understanding of their agroforestry management—i.e., the misunderstanding of it as mere extractivism—is an example of this biased perception.

Caboclos' use of the *várzea* (Amazonian floodplain) for agriculture is still a challenge for farming studies. As Ross (1978:198) states, "The main question remains; [that of] why peasant economic strategies did not include any significant utilization of the rich soils of the *várzea*." The main focus has been on the analysis of the role that economic extractivism has played in supposedly limiting the caboclos' agricultural intensification. Attention has been concentrated on the role of caboclos in the intensification of grain production, such as of maize and rice, while less concern has been dedicated to intensification of local production systems and crops. However, an increasing number of studies of caboclo production systems, agroforestry, ethnoecology, and marketing have helped to complement and broaden the analysis. Swidden agriculture in the uplands and agroforestry in the floodplain coevolved with the extractivist economy. While these activities coped with extractivist social and land tenure structures, they improved the food security of households and provided an occasional surplus for market. The caboclos' intimate knowledge of floodplain ecology allowed them to nurture their environment towards intensive systems of food and raw material production, among which are the so-called floodplain agroforestry systems, that are invisible to conventional measures of production. However, explaining the current mode of agriculture and agroforestry production of caboclos requires a longitudinal analysis of the colonization and extractivist history of the Amazon.

Colonization, Extractivism, and Caboclo Agriculture

During the first centuries of Portuguese colonization of the Amazon floodplain, indigenous peoples represented the only labor force to exploit forest commodities of interest to the European market. Expeditions to capture and enslave indigenous labor were widely organized by Portuguese colonizers. This practice, characterized by cruelty and unscrupulous extinction of indigenous groups, raised controversies among colonizers, Portuguese royal authorities, and missionaries. For the Portuguese royalty and for missionaries, Indians were to be integrated into the "state" and "Christian society" mainly through their labor power, but pacifically. In 1563, the Portuguese crown called upon missionaries (mainly Jesuit, but also Mercedarians) to "civilize and protect" Indians from colonizers and "slave hunters." Missions were installed all over the region, but mainly in the lower Amazon and in the estuary, an area already under Portuguese control.

Two mechanisms were fundamental to the missions' success. First, the Jesuits established a *lingua geral* (general language), or *Inhengatu*, mixing the indigenous Tupí and Portuguese languages. Second, they persuaded the Indians to take part in merchandise-oriented cash cropping, ranching, and extractivism under the control of local missions. The missions restricted the labor force required by colonizers to carry out a more extensive extractivist economy of great interest to the Portuguese royalty. However, the confrontation between missionaries and civilians motivated the Portuguese crown to expel the Jesuits from the region in 1757. Later, in 1794, the Mercedarians were also expelled.

Furthermore, the Portuguese crown created the *diretórios* (directorates), following a structure similar to the missions but more clearly devoted to "integrating" Indians definitively within the state as an available labor force. The *lingua geral* was forbidden in favor of Portuguese. The directorates strongly emphasized interracial marriage among Portuguese, Indians, and African descendants, and the wearing of Western clothes, as integration strategies. Considered inefficient by the crown, the directorates were abolished by the end of the 18th century. The directorates contributed decisively to the "caboclization" process of the floodplain indigenous people (Parker 1985).

The directorates were in place from 1757 to 1790, following the expulsion of the Jesuits, with the assignment to "organize" agriculture and increase its labor force with the "integrated" Indians. Subject directly to Portugal's crown and to the Conselho Ultramarino (Overseas Council), their aim was to increase commodity exportation to European centers, as well as to urban centers and military bases scattered over the region. During the directorate period, agriculture was categorized into two main systems, "plantation" and "subsistence" (see R. Anderson 1976). While plantations were designated for white settlers, subsistence agriculture was carried out by Indians but controlled by the directorate administration. Plantations were mainly monocrop-oriented and large-scale operations with a focus on export production. In contrast, subsistence agriculture aimed at supplying such foods as manioc, beans, and maize to local populations, but the directorate decided what and how much to plant.

An important aspect of this period is the transfer of land ownership. The Jesuits' latifundia were divided into large farms and granted or sold to Portuguese settlers to establish plantations or cattle ranches, maintaining ownership control in the hands of the few. Land grants were given mainly along the floodplain but also encompassed large tracts of upland forest. By the end of the directorate period, essentially all floodplain areas were under white settler control, while Indians were restricted to the plots assigned by the directorate or were working on plantations. Following the Jesuit system, Marajó grasslands were almost exclusively dedicated to cattle ranching, while other floodplain areas were designated as plantations. Interesting to note is the establishment of plantations based on agroforestry systems, as in the case of cacao and coffee, which were planted in shaded areas (R. Anderson 1976). Finding few reports citing problems with coffee in the agricultural records of the period, R. Anderson (1976) deduced that it was probably suited to the area and economically attractive. Plantation systems also developed large agricultural areas on the floodplain, mainly dedicated to rice, cacao, and sugarcane.

The formation of the caboclo sociocultural system occurred in this scenario. Caboclos have emerged on the "edges" of Amazonian history, seen as a labor force, not as producers. The process of riverine settlement imposed by the later rubber economy only reinforced the subjugation of the emergent caboclo population to the large landowners. Despite their importance, caboclos never had a place of their own in the floodplain. That circumstance alone may answer Ross' (1978:198) question, posed earlier.

Although the directorates had a strong impact on the socioeconomic structure of estuarine agriculture, it was the transition to a rubber-oriented economy in the late 19th century that most decisively shaped the current mode of caboclo agricultural production. The wild rubber economy employed almost the entire agricultural labor force. Plantations entered into decline during the first half of the 19th century due to labor shortages, despite a growing market in regional urban centers. The crisis worstened after the abolition of slavery in 1888.

The settlement pattern required by wild rubber extraction was one of independent household units following the distribution of resources along the floodplain and the dictates of the tenure structure imposed by landowners. Rubber tappers were subjected to forced labor and slavery, as well as forced dependence based on debt servitude, *aviamento*. During the directorates, individuals and production systems were ruled by the area's directors, whereas the system of *aviamento* substituted a much stronger form of control and dependence. This relationship is presented in Euclides da Cunha's *A Margem da História* (1941), which describes the rubber tapper as a man working to enslave himself.

Extractivism not only limited the agricultural development of the region, but reinforced economic isolation and a social structure of dependence between tenant and owner of resources. Weinstein (1983) notes that the power of a *seringal* (an area of wild rubber production) owner extended not only over the land and the rubber trees but over the *seringueiro* (rubber tapper) himself. The constant fractioning of groups and communities to fit the extensive nature and seasonality of extractivism constricted the development of social and political organization at the local level, as well as the emergence of an agricultural system focused on local rather than on outside economic advancement. Although different in structure, this period is marked by the same political ideology as that of the directorates—one focused on the production of commodities for exportation, with a lack of concern for the costs to the local population and to regional development.

After the decline of the rubber economy at the beginning of 20th century, a new cycle of floodplain agriculture based on rice and sugarcane began in the estuary. These activities occupied an impressive areal extent in the floodplain during the following decades, but they declined after the 1950s. However, these production systems developed according to the same model of directorate plantations. Thus, caboclos were not involved as independent producers but, as before, were absorbed as a labor force. In this scenario, floodplain agroforestry combined with upland swidden agriculture evolved as adapted land use systems parallel to extractivism and plantations.

The land use system based on swidden gardens of manioc in upland soils was a system already in place and suited to the labor priorities required by extractivism. Manioc offered a number of advantages to the extractivist, such as lower labor requirements; a stable caloric source, manioc was suited to low fertility and acidity of upland oxisols and was storable for a long time in situ. Manioc was, thus, a crop that made flexible use of household labor. In this sense, manioc gardens were a secure mode of production adapted to the uncertainty of an extractivist economy, to the needs of riverine households, and to a debt system that pocketed a producer's extractivist yield and prevented the accumulation of savings and capital at the household level. In some cases, however, the *seringueiros* were not even allowed to grow manioc gardens but had to buy food (manioc flour) from their landlords, using their rubber harvest earnings, reinforcing a structure of debt servitude.

Therefore, the development of labor-intensive floodplain agriculture, such as for grain production, overlaps with the socioeconomic settings of extractive and plantation industries, and with a land tenure system based on outside ownership. Even if allowed, the economic risk of more specialized agriculture has been too high to be undertaken by uncapitalized and unassisted riverine populations. Besides environmental risks related to flooding and pests, the risk of having the output confiscated by owners needs to be considered. The most feasible alternatives for floodplain inhabitants have been the consortium of short-cycle agriculture and management of native economic species, and/or management of economic species already widely available in the vegetation, such as the açaí palm.

Early Amazonian travelers, such as Wallace (1853), Bates (1988), and Spruce (1908), had enthusiastically noted the high concentration of palm and fruit trees surrounding riverine dwellers. The management strategy that mimics gardening and native vegetation has long provided a diversified resource pool for Amazonians (Beckerman 1979, Lathrap 1970, Roosevelt 1989). However, it is only recently that better understanding of native agroforestry systems has come about (Anderson et al. 1985, Balée & Gelly 1989, Denevan & Padoch 1987, Moran et al. 1994b, Posey 1985). The main challenge to these systems has been how to increase surplus production without exponential increases of labor input. The ability to expand agroforestry systems into floodplain forests is based on progressive

management that incorporates previously unmanaged areas into the resource pool. Management is undertaken at the species level, not at the level of the whole spectrum of vegetation, which makes this agricultural "transformation" not easily recognized by outsiders. Floodplain agroforestry offers advantages such as low cost, high productivity, and low risk. For these reasons, forest management, not short-cycle agriculture, has been the main food production system in the floodplain during the last two centuries. Its compatibility with rubber, logging, and other extractivism-oriented activities has minimized the risk of conflict between land users and landowners, while providing households with food at minimal labor costs.

Açaí agroforestry illustrates the potential for intensification of this system when opportunity, such as market demand, is favorable. Although the floodplain environment has been successfully used by its inhabitants as part of local agroforestry technology, the agroforestry strategy has remained "invisible" as a production system. This is especially true in the case of sharecroppers, who cannot claim any rights to the land or reimbursement for land improvement based on forest management, despite the labor and technology applied to create intensive agroforestry systems. Let us look again at the example of açaí agroforestry. Before the 1970s, when açaí fruit still had a weak market, sharecroppers were allowed to commercialize their harvests themselves and had a free hand in managing their surroundings. This scenario has changed in proportion to the growing market value of the fruit. Former absentee landowners have reinforced the sharecropping system in açaí production areas, many times taking advantage of previous forest management carried out by their tenants. Nowadays, in addition to controlling harvesting activities, such as when and how much to harvest, most landowners sell the crop themselves, later sharing part of the profits with their tentants.

Agricultural Intensification in the Context of Land Use

The points raised in the previous sections lead to the conclusion that intensification models and comparative analysis of food production systems, such as açaí agroforestry, need to integrate a larger array of variables. Intensification does not proceed linearly, dependent on one factor (e.g., population growth or market demand), nor is it ahistorical. Instead, it occurs as a combination of these factors with other variables, such as internal population dynamics and opportunities offered by external sources (e.g., incentives from development projects). Thus, intensification responds to multilineal processes combining variables operating on multiple scales that interconnect regional, local, household, and individual levels.

Land use history is an important component of agricultural analysis, since it reflects the correlation between the present condition of plant/soil interaction and past socioeconomic events and management practices motivating land use change. Thus, the history of use provides a good understanding of the land use impact of a particular farming technique. The focus on *processes* of land use intensification, that is, coexistence of land use strategies, is more relevant than characterization of *stages* of intensification, such as frequency of cropping in a given area. A land-use-based approach makes it possible to grasp the process of coexistence between intensification and deintensification as related to temporal variation of land use strategies. For instance, increased intensification in one production zone may coexist with transient deintensification in another (see Guillet 1987). This is the case of many Amazonian estuarine populations, who have virtually abandoned swidden agriculture in the upland forest in favor of açaí production and trading. However, the thriving regrowth of fallows subjected to swidden agriculture allows manioc agriculture to be reconsidered whenever neecessity arises. Another common case in the estuary is that of areas that have received the heavy impact of repeated mechanization of agriculture (in general called "intensive") which, besides creating dependency on tractors and fertilizer, has limited the regrowth capacity of vegetation, thus constraining future uses of the area. Within this framework, patterns of intensification may be defined in terms of the capacity of the ecosystem to sustain future uses. Thus, variability in land use intensification can be reinterpreted in terms of flexibility of economic and ecological strategies, rather than in terms of input/output ratios at one point in time only.

Another important aspect to be considered in a multilevel analysis of intensification is the unit and scale of analysis of land use systems. In putting site-specific measures in a regional perspective, one needs to scale up from a garden plot to a farm, a population to a landscape and, finally, to a regional context of intensification. For instance, the impact of agriculture on the vegetation/soil complex imposes an ecosystemic function on the landscape and, thus, is seen within a spatio-temporal setting. We may ask how much a given practice affects the regrowth capacity of vegetation at the site and how it changes landscape heterogeneity over time. In other words, a highly intensive system in the short term (e.g., artificially fertilized agriculture), which limits the use capacity of the land in the long term, can be seen as extensive rather than intensive, and as temporally unsustainable. The capacity for continuous use and the maintenance of a larger economic portfolio (i.e., the opportunity to shift to other activities) defines intensification as a dependent variable of sustainability, that is, a definition that accounts for the ability to maintain production over time, without constraining change in the production system in the future.

THE FIELD DATA

The data presented here derive from our 1994-95 fieldwork, which focused on understanding the production system of açaí agroforestry and its relationship to land use change. However, our research in the area began in 1989. Special attention has been given to three populations representing different economic and land use patterns. Ethnographic, socioeconomic, and ecological accounts concerning these populations can be found in Murrieta et al. (1989), (1992), Neves (1992),

Brondízio & Neves (1996), Brondízio et al. (1994a-b), Murrieta (1994), Siqueira et al. (1993), and Brondízio (1996).

The present paper draws upon a series of previously published works focused on land use change and landscape analysis of the study area. Methodology and results concerning the use of Landsat Thematic Mapper satellite images to classify 14 land use/cover classes, including unmanaged floodplain forest, açaí agroforestry, and three stages of forest succession, can be reviewed in Brondízio et al. (1993a-b, 1994, 1996), Brondízio, Moran, Siqueira et al. (1996), Moran et al. (1994b), and Mausel et al. (1993). Special attention has been given to the integration of field and remotely sensed data, i.e., incorporating data collected from site-specific vegetation and agroforestry inventories into satellite images to generate micro- and meso-regional scale land use classification maps. This methodological procedure is referred to as a multilevel analysis of land use that involves data integration at four different scales and contexts: landscape, vegetation class, farm/household, and soil (Brondízio 1996). This model of data collection relies upon a nested sampling procedure that produces data that can be scaled up and down, independently or in integrated fashion. The combined use of multi-temporal, high-resolution satellite images with local-based data on land use history and site-specific vegetation and agroforestry inventories makes it possible to understand ecological and social dimensions of land use at a local scale, and to link them to regional and global scales of land use and land cover dynamics.

The Study Area

The study area is located in the estuarine region of the Amazon, on Marajó Island, in the municipio of Ponta de Pedras, state of Pará (see Figure 1). It is a transitional region between two macro-environments—natural grassland and forest—most of which are flooded areas (Pires 1973, Prance 1980). According to Lima (1956), the floodplain covers 25,000 sq km (about 50%) of the Amazon estuary. Calzavara (1972) estimates that açaí-dominated floodplain forests occupy 10,000 sq km in the estuary. Mangrove is another major vegetation class in the floodplain.

Upland forest occurs at sites that date from the tertiary period. These sedimentary areas are dominated by oxisols with sandy texture and low pH. Vegetation regrowth in different stages of secondary succession is widely scattered in the area as a result of shifting- and conventional-based agriculture and cattle ranching. Grassland savannas (RADAM 1974) are one of the most prominent features in the study area. Three grassland savanna types can be identified in the area (Brondízio et al. 1993b). Between the grassland areas and the forest, one can identify a transitional forest characterized by the dominance of palms and vines. Within the natural grasslands are islands of forests, some of them on mounds of likely prehistoric origin and others related to drainage characteristics.

The human population of the region may be found in small urban centers or scattered along the river banks in a typical pattern going back at least to the rubber

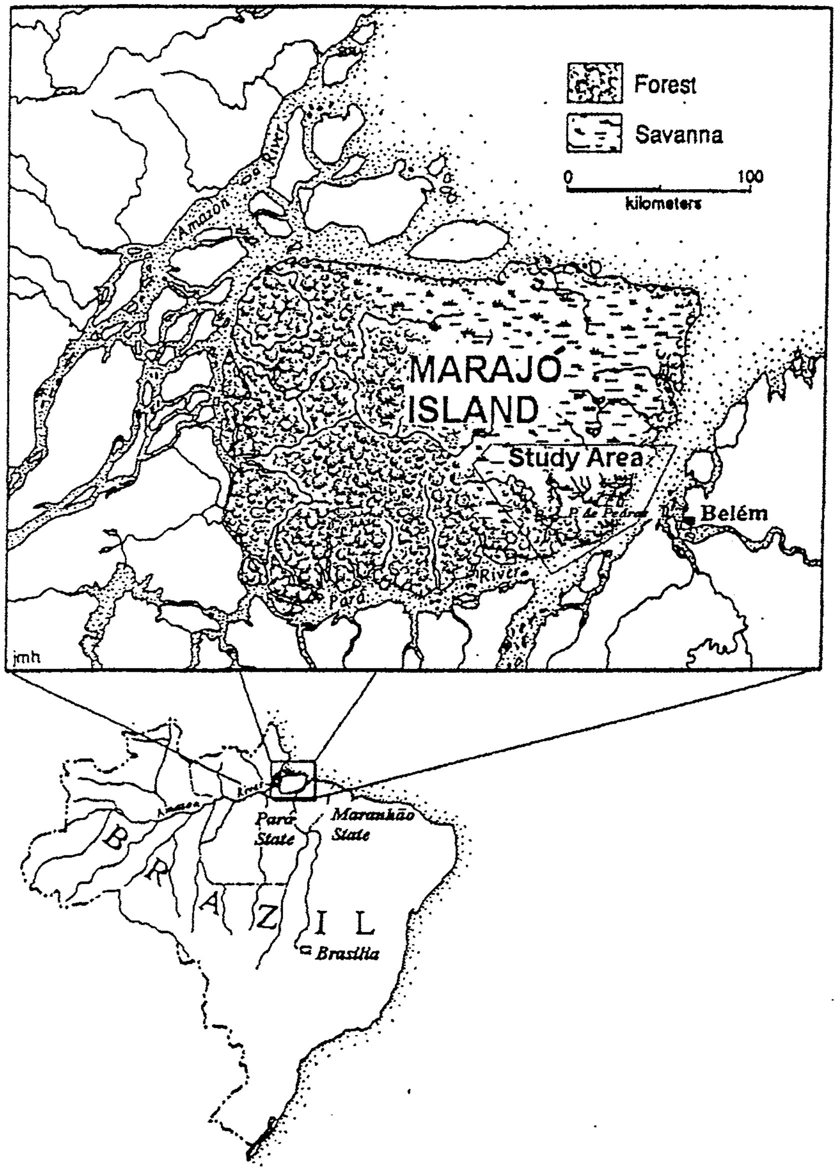

Figure 1. The Amazon Estuary, Showing the Study Area in Relation to Marajó Island, the City of Belém, and Pará State

boom period of the 19th century (Wagley 1953; Moran 1974, 1990; Parker 1985). The prehistoric people of Marajó have long attracted attention, resulting in a substantive literature (Meggers & Evans 1957, Roosevelt 1989, 1991) that has tried to explain the presence of large-scale settlements and mound-buildings cultures. The dominant explanations posit either external occupation followed by devolution or endogenous developments that antecede even those of the Andes. In contrast, very little attention has been paid to the populations on Marajó Island since contact with Europeans. In the last 20 years, the rate of socioeconomic change in Amazonia has motivated fundamental transformation of caboclo populations. The increasing influence of the market and of government and private development projects has motivated these populations to make a variety of changes in subsistence strategies and social organization. The effects of these changes in demographic patterns, social organization, economy, and well-being, as well as their environment impact, await studies that seeks to understand caboclo responses to them.

Inventory Data

Vegetation and agroforestry stand inventories were developed for 10 areas characterizing different levels of management of açaí agroforestry. These data are too extensive to present fully here (see Brondízio 1996), but a summary table of the forest inventories (Table 1) and the following descriptive information provide insight into them.

The selection of the ten açaí agroforestry and the two unmanaged floodplain forest sites for inventory took into account the number of years the former had been managed and the location of the managed areas within the region. During the inventory, four adjacent plots (25m × 25m) and four nested subplots (2m × 5m) were selected in each agroforestry site. In each plot, all the trees with a DBH (Diameter at Breast Height) greater than or equal to 10 cm were identified, their DBH measured, and their stem and total height recorded. All açaí with DBH equal to or greater than 5 cm were counted, recording the number of stems per clump. In the subplots, all the individual plants (including herbs, seedlings, and saplings) were identified and counted, and saplings (tree individuals with a DBH equal to or greater than 2 cm) were measured for DBH and total height. In the unmanaged floodplain forest areas, the number of plots was doubled to eight plots of 25m × 25m and four subplots of 2m × 5m each. These data were entered on a spreadsheet (Quatro Pro 3.0) and processed to derive information on vegetation and agroforestry structure (e.g., density, biomass, and height) and composition. In each inventoried area, geographical coordinates were obtained by the use of a GPS (Global Positioning System) device. These data were then geo-referenced to a satellite image (Landsat TM of 1991) to inform land use classification.

During the 1994-95 açaí fruit harvesting season, a series of field experiments were carried out with the goal of measuring the açaí fruit production in agrofor-

Table 1. Floodplain Forest and Açaí Agroforestry: Summary of Stand Inventory, 1994

Sites	*Years of Management*	*Area Sampled (m^2)*	*Number of Species*	*Açaí Clumps per Hectare*	*Açaí Stems per Hectare*	*Açaí Stems per Clump*	*Basal Area (m^2/ha)*	*Açaí Basal Area (m^2/ha)*
Floodplain Forest	Unmanaged	5,000	44	156	326	7.5	31.63	2.28
Floodplain Forest	Unmanaged	5,000	45	208	528	6.6	29.37	4.22
Açaí Agroforestry 1	3-5	2,500	28	480	2,348	4.9	41.97	6.63
Açaí Agroforestry 2	5	2,500	17	516	2,016	3.9	28.05	10.13
Açaí Agroforestry 3	10	2,500	16	524	1,440	2.7	23.92	9.16
Açaí Agroforestry 4	10	2,500	13	444	2,248	5.0	23.59	8.65
Açaí Agroforestry 5	10	2,500	18	868	3,428	3.9	25.70	13.10
Açaí Agroforestry 6	10-13	2,500	20	468	2,268	4.8	30.04	11.40
Açaí Agroforestry 7	15	2,500	24	588	2,488	4.2	30.02	12.50
Açaí Agroforestry 8	20	2,500	15	572	1,984	3.5	24.51	12.60
Açaí Agroforestry 9	20	2,500	14	872	2,832	3.2	28.79	10.80
Açaí Agroforestry 10	20	2,500	11	516	1,880	3.6	22.82	9.44

Table 2. Açaí Fruit Production Experimental Sites, Ponta de Pedras, Pará, 1994-95

Sites	*Management History*	*Producers and Their Land Tenure Characteristics*
1	Unmanaged floodplain forest	*Producer A:* Medium-sized owner of 100 ha, inherited more than 20 years previously.
2	10 years of management (thinning and weeding but no pruning)	*Producer A:* see above.
3	10 years of management (thinning, weeding, pruning, planting, annual maintenance)	*Producer B:* Small-sized owner, holding 15 ha, inherited 10 years previously.
4	5 years of planting to açaí agroforestry (roçado de várzea)	*Producer B:* see above.
5	1 year of initial management (selective thinning, pruning, and weeding)	*Producer C:* Affiliated with cooperative, which designated 2 ha of land for his use.
6	3 years of management (intensive thinning, pruning, and weeding)	*Producer C:* see above.
7	2 years of management (initial thinning, weeding, and pruning)	*Producer D:* Sharecropper of 20 ha belonging to a larger landowner (200 ha), whose land is divided among 4 sharecroppers.
8	2 years of management (initial thinning, weeding, and pruning)	*Producer D:* see above.

estry areas managed at different levels of intensity. Four different açaí producers agreed to record açaí fruit production during the whole harvesting season (from August 1994 to February 1995). Each producer provided two agroforestry areas for experimental purposes. The selection of these areas was based on both socioeconomic (e.g., land tenure and property size) and agroforestry (e.g., years of management) criteria. The four producers and respective eight selected experimental areas are described in Table 2.

The selection of experiment areas was based on interviews with the producers about the areas' management history (e.g., first years of management and techniques applied) and on field surveys to determine the exact location and boundaries of the experimental area. Each area designated for experimental purposes measured 25m × 25m. A cord was used to "fence" the area and restrict its use to the experiment's purpose (from August 1994 to February 1995). Inside each area, a smaller plot of 10m × 10m was marked and fenced in the same way. The location of these smaller plots was based on a random selection.

In the large (25m × 25m) area, a complete inventory was taken of all trees with DBH equal to or greater than 10 cm and of all açaí stems with DBH equal to or greater than 2 cm; species identification, DBH, total height, and number of açaí stems per clump were recorded. During the whole season, the weight of all açaí fruit bunches harvested in the area was recorded. In the smaller (10m × 10m) plots, all açaí clumps and respective stems were labeled, to allow recording of the production of fruit in each stem and clump, as well as to map the location of each clump.

Each producer was trained in the experiment's procedures and was given a notebook to fill out during the harvest. The orientation involved a clear statement of the goals of the experiment, the use of a scale for weighing açaí fruit bunches, and how to record the number of açaí stems and clumps harvested. However, in the vast majority of instances, the research team itself was present to record the harvesting of all the sites.

From August to December 1994, the researchers followed the major marketing activities and interviewed middlemen, açaí market workers, and producers from other areas of the Amazon estuary. Five large local producers of açaí fruit also collaborated in this research with private data about production and prices of açaí fruit. Archival research was done at FIBGE (Brazilian Institute of Statistics and Geography), in Belém, to assess the production of açaí fruit and açaí heart of palm in the study area, region, and country.

An Overview of the History of Açaí Economy in the Estuary

The estuarine economy has gone through multiple cycles during the past 150 years, but one can argue that, since the end of the rubber boom in the 1910s, only açaí resources (fruit and heart of palm) have involved as many people and had the same economic significance.[2] However, the most important aspect of the açaí economy is the possibility it has created for caboclo populations to play a key role in a major regional activity. Contrary to other floodplain economies (e.g., rubber, rice, sugarcane, and cattle ranching), in which caboclos were considered only as labor force, açaí fruit has allowed caboclos, for the first time, to play a key economic role as producers.

Agriculture in estuarine floodplains, despite its potential (Lima 1956), has been relatively modest in economic terms. Around 1917, immediately after the decline of the rubber economy, rice began to be planted in floodplain areas of the estuary. Another important cycle was marked by the sugarcane mills. Sugarcane plantations were started on the floodplain in the 1920s. At that time, most plantations occupied areas of approximately 2,000 ha. During the 1950s and 1960s, the average size increased to an estimated 10,000 ha. The sugarcane economy peaked between 1960 and 1975 and then faded because of economic development policies at the national and regional levels (see S. Anderson 1992). Another major economic activity is the lumber industry, dedicated to plywood processing based on *Virola surinamensis*. Timber harvesting began in the region in 1956 (A. Anderson et al. 1993).[3] The emergence of this industry was a result of increased demand by international markets as well as the breakdown of incipient floodplain agriculture.

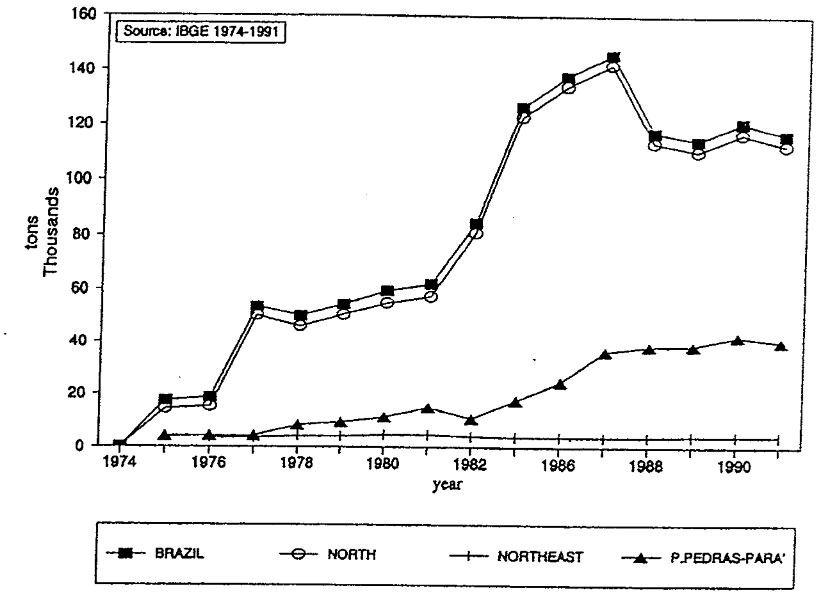

Figure 2. Brazilian Production of Açaí Fruit, 1974-1991

The so-called *açaização* (after Hiraoka 1994) of the estuary symbolizes the importance that açaí agroforestry has gained during the last 25 years in the region. The most notable reason is the expansion of the urban market, especially around large urban centers such as Belém. The rate of rural out-migration began to increase drastically in the region during the late 1960s and early 1970s. The migrants brought to the city their dietary habits, strongly based on açaí and manioc flour. In addition, açaí could provide an affordable food source compared to other staple foods, which were generally imported from the south of Brazil.

Belém's population has grown from approximately 300,000 in the 1950s to nearly 2,000,000 today, mainly composed of low-income inhabitants living in floodplain areas surrounding the city. As shown in Figure 2, açaí fruit production increased five-fold during the period from 1975 to 1991.[4] According to FIBGE data (1991), around 110,000 tons of açaí fruit are produced in the estuarine region. Of total Brazilian production, more than 95 percent comes from the state of Pará, although the state of Amapá is growing in importance.[5] We estimate that commercialization of açaí fruit generates U.S.$15 million for producers, U.S.$1.5 million for transportation, and U.S.$3.75 million for market brokers, while processing and comercialization of açaí juice amounts to U.S.$55 million. Overall, we estimate that açaí fruit supports an economy of at least U.S.$75.25 million/year in the estuary.[6] Market availability for açaí, coupled with lack of immediate promise of agricultural production in floodplain areas, provided new opportunities for caboclo populations who already knew the agroforestry production techniques for açaí fruit. Today, açaí fruit is the most important income source for a vast majority of riverine households, as shown by data from the regions of Ponta de Pedras (POEMA 1994), Abaetetuba (Hiraoka 1994), and the islands (e.g., Ilha das Onças) (Anderson & Ioris 1992). In Ponta de Pedras (Praia Grande community), açaí represents 64 percent of household income generated from agricultural products (including rice, beans, and coconut). In Abaetetuba, açaí fruit is responsible for 50 percent of the household income of families involved in agroforestry, whereas in Ilha das Onças, açaí reportedly represents 63 percent of the income generated by commercial products.

The Socioeconomic Structure of Açaí Fruit Production

The intensification of the açaí economy during the past 25 years has created a complex socioeconomic structure based on land tenure and market access. Despite the overall participation of caboclo populations in açaí production and marketing, there are some significant aspects that differentiate caboclo producers: resource ownership, freedom of decision making, and control over yield.

Between producer and consumer, various participants are involved in the processes of resource management, harvesting, transportation, market brokering, market distributing, processing, and exporting, as sketched in Figure 3. There are variations among açaí producers due to landholding size and control. Landholdings can be small or medium/large. Caboclos who are small owners are characterized by landholdings of 1-50 ha that are used exclusively by households for subsistence and market production. Medium and large owners are mainly urban entrepreneurs, although a few rural caboclos have reached this status, with rural properties of 50-200 ha. Some estates are larger than 200 ha. Despite the differences in property size, medium and large owners are both dependent on sharecropping for production.

Caboclos who are sharecropper are part of a socioeconomic category that varies widely in terms of origin, time of land occupation, right to resource use, and role within the land. A dissimilar and relatively new category of producers are called *arrendatarios* (lessees). Associated with lessees are the so-called *apanhadores* (harvesters). They are usually landless caboclos subject to a large/medium owner or to an *arrendatario*.

Açaí management and planting activities are directly related to the degree of autonomy a person has over the resource. Land tenure creates a line that distinguishes decision making among caboclos who are small owners and those who are sharecroppers. Management can take a variety of pathways in relation to intensification of production. Whereas small owners are independent in resource management and can decide which level and means of intensification to proceed with, sharecroppers are bound by the landowner's decision regarding pace and degree of intensification. The possibility of creating legal ties to a

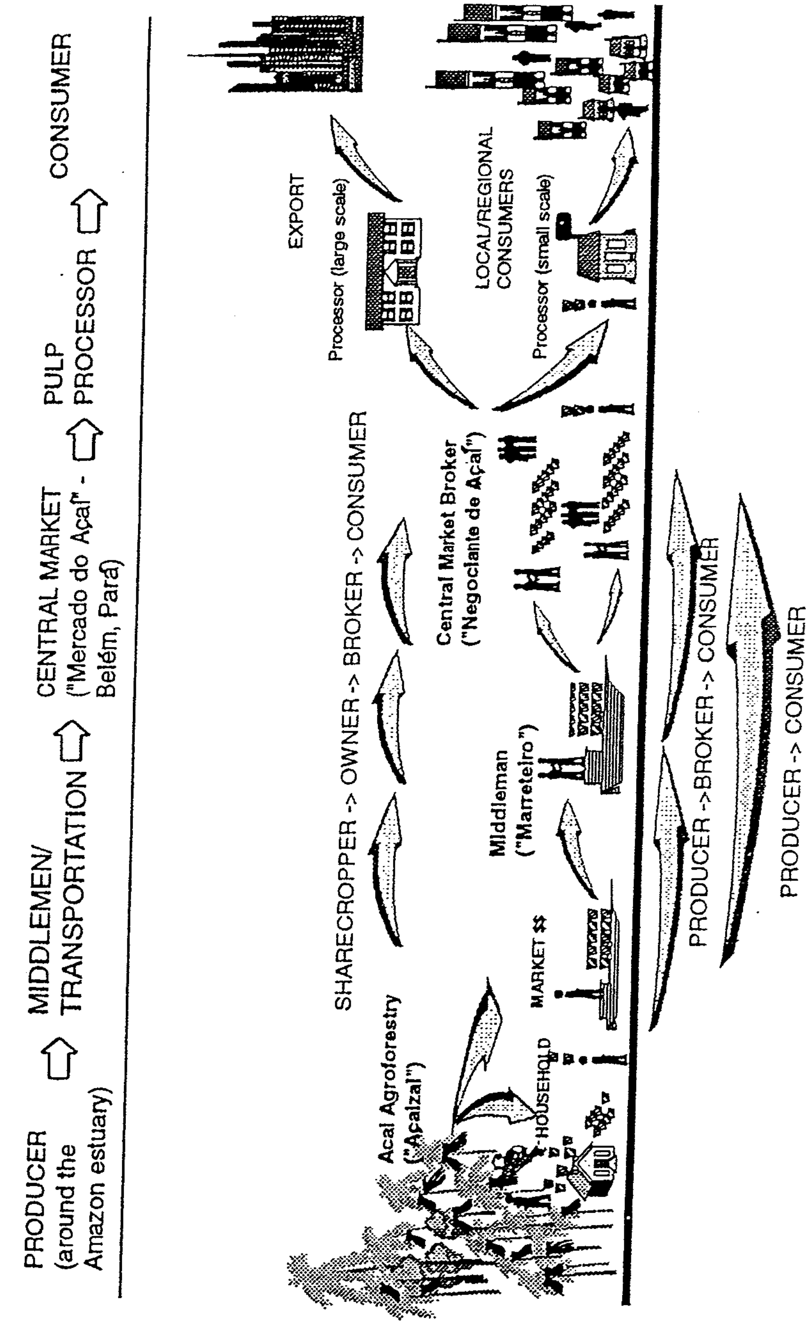

Figure 3. Pathways of Açaí Fruit from Producer to Consumer

piece of land and, thus, acquiring right of ownership is a frequent threat to absent landlords. For this reason, the categorization of açaí fruit as an extractivist resource rather than as a production system can be seen as advantageous to landowners. Since açaí management maintains forest vegetation, it is not recognized as a "benefit" (improvement) to the land in legal terms, thereby obscuring the sharecropper's labor input on the managed land. Although some sharecroppers have the "freedom" to decide upon management strategies, they are reluctant to increase their labor input since the threat of being expelled from the land is often presented.

Small owners, on the other hand, are generally engaged in more than one means of management, including the management of natural stands, housegardens, and planted agroforestry (*roçado de várzea*). Management of natural stands can also be intensified at a significant pace. Some important reasons behind such management are the possibility of quick expansion of the production base, an increase in property value, an increase in income in the medium and long term, and the possibility of quick capitalization resulting from exploitation of timber and heart of palm.

Differences in land tenure also explain the main differences between the marketing strategies of caboclos who are small owners and those who are sharecroppers. Two main decisions are involved: first, about the beginning and periodicity of harvesting; and second, about to whom to sell the production. The decision on the harvesting period is directly related to market fluctuations and household needs. Whereas owners have autonomy in weighing the risks of waiting for better prices, sharecroppers need to follow the owners' schedule and decisions. Thus, sharecroppers may be subjected to selling all their production when the lowest prices are to be had.

The second decision, market choice, has far more complex arrangements associated with it. Transportation and marketing infrastructure has historically been one of the main constraints on the regional economy. Distance, isolation, and lack of access to transportation means and capital have excluded a large number of Amazonian producers from taking part in the market without the interference of middlemen. This circumstance has created a complex structure of middlemen and a dependency on "intermediate" markets for both small owners and share croppers.

The bulk of estuarine açaí fruit production ends up in Belém, while a smaller portion is sold to local dealers in small towns around the estuary. Belém's main market, "Feira do Açaí," concentrates production from all over the estuary and from the state of Maranhão, making it a rather large açaí market compared to other regional products. At the peak of the harvesting season, the number of açaí baskets (*paneiros*) in the market reaches 10,000-15,000 per day, the equivalent of 150-180 metric tons/day of fruit being negotiated for local consumption and exportation to other parts of the country, such as Rio de Janeiro, São Paulo, and Brasília.

The açaí market is organized around brokers who share different lots on the ground of an open area near the famous "Mercado do Ver-o-Peso" on the shore of Guajara Bay. During the main season, one can find up to 100 brokers and about 300 manual transporters working exclusively with açaí. Market price for açaí is regulated by a combination of quantity and quality factors. Quantity regulates the supply and demand principle, thus providing a basis for daily and seasonal price fluctuation. On the other side, quality and point of origin of the fruit regulates the variation in prices among brokers. Açaí producers know that quality is a large consideration in determining price. For this reason, they allocate a considerable amount of time to the selection of fruit and careful preparation of each basket. Dry and rotten fruits are discarded, as are twigs and leaves. There is also a careful selection of "perfect" fruits for the top layer of each basket (each of which holds about 11-12 kg of açai fruit).

The evolution of açaí prices during the last decade has shown a respectable performance, even when compared to all major crops and husbandry products in the state (Brondízio 1996). Also important is the consistent market for the product during the last decade, which shows signs of a well-structured production system. Production has increased five-fold during the past 15 years due to management and planting, rather than extraction from untapped sources. Increased production and price maintenance have been followed by the emergence of a new socioeconomic organization around production, distribution, marketing, and processing, introducing a new class of producers and workers emerging from an extractivist economy but already functioning as an agricultural category.

Açaí Agroforestry Management

Açaí agroforestry management has been the focus of a considerable number of studies in the Amazon estuary, especially after the 1980s, when a marked increase in fruit production could be perceived (Calzavara 1972, Lopes et al. 1982, A. Anderson et al. 1985, Jardim & Anderson 1987; A. Anderson 1988, 1990, 1991, 1992; Murrieta et al. 1989, Jardim 1991, Anderson & Ioris 1992, Peters 1992, Neves 1992, Jardim & Kageyama 1994, Hiraoka 1994; Brondízio et al. 1993a-b, 1994, 1996; Brondízio, Moran, Siqueira et al. 1994, Moran et al. 1994b). Despite such attention, many aspects of açaí agroforestry systems are still poorly understood, such as levels of management intensity, spatial distribution of managed areas, and associated planting techniques. This section explores some of these aspects of management and characterizes levels of intensification based on the inventory of 10 açaí agroforestry sites and two floodplain forest sites located around the town of Ponta de Pedras (Table 1).

Our understanding of agroforestry management requires knowledge at two levels: site-specific and land use. Whereas the study of site-specific management can reveal the level of management applied to changes in structural and functional characteristics of the vegetation stand, it is limited for showing the spatial extension of these areas Spatial analysis of management is important in revealing spatial interactions between areas managed at different intensity levels and their interrelationship with other land use classes. For instance, based on a classification of a 1991 Landsat TM image of the study area of Ponta de Pedras, we found that, on average, 25-30 percent of all floodplain forest area is occupied by açaí agroforestry (Brondízio et al. 1994a-b, 1996; Brondízio 1996). This figure indicates that the areal extent of açaí agroforestry represents nowadays the most economically important land use class in the region.

Açaí palm occurs in relative abundance in estuarine floodplain forest, varying in density and distribution depending on environmental and anthropogenic factors. Different management and planting strategies transform these areas into açaí agroforestry, known locally as *açaizais*. The term encompasses different intensities of management, population densities, and vegetation structure, as well as a wide range of species composition.

The three main means of açaí agroforestry development are: (1) management of native stands; (2) planting of açaí stands following annual or biannual crops, that is, *roçado de várzea*; and (3) combined management and planting in native stands. Management of native stands can be understood at two different levels: forest stand and plant levels. At the forest stand level, thinning and weeding techniques are used. At the plant level, management focuses on pruning techniques. During the development of the açaí agroforestry, weeding and pruning are used to encourage the development of seedlings and to control the density of stems per clump. These techniques are maintained continuously over the years during the formation of a dense açaí stand.

Planted Açaí Agroforestry: The Roçado de Várzea

Roçado de várzea is an intensive intercropping system that combines annual, biannual, and perennial crops in a spatio-temporal sequence resembling stages of secondary succession. This system has been described in Siqueira et al. (1993), Moran et al. (1994b), Hiraoka (1994), and Brondízio (1996).

A *roçado* is prepared by slashing and burning. During slashing, species considered important, such as rubber trees, remain untouched. Once the area is burned, careful cleaning removes unburned branches and prepares the area for intercropping. A sequence of *roçado de várzea* is presented in Figures 4, 5, 6, and 7. As noted by Hiraoka (1994), *roçados* are unique in terms of plant combinations, as each producer can sort different spatial and temporal arrangements of plants. However, the technique used to plant a *roçado* is similar among producers, as is the end product characterized by açaí-dominated agroforestry.

Planting usually starts with a mixture of annual, short-cycle crops and biannual species (see Figure 5). Short-cycle species such as pumpkin, watermelon, and cucumber are dispersed around the site, while other annual crops, such as maize, rice, okra, sesame, and sweet manioc, are planted in alternating rows or clustered

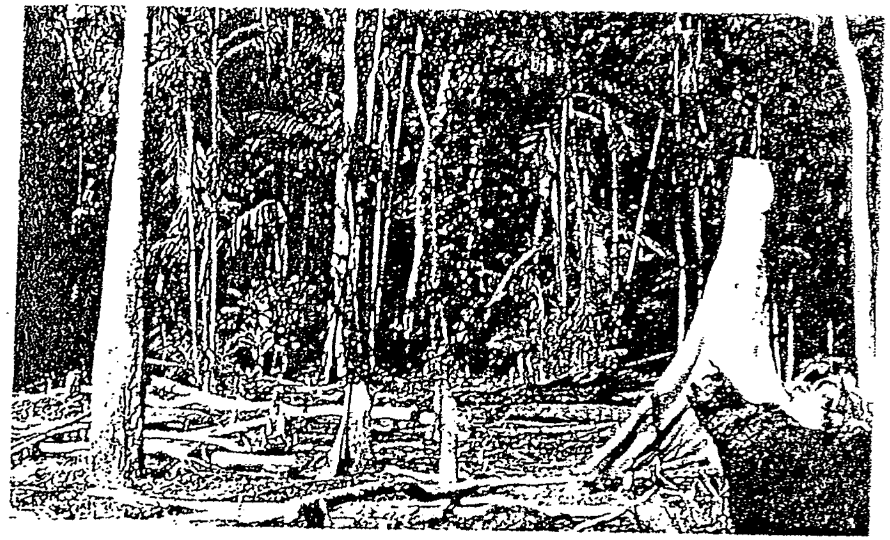

Figure 4. The Clearing Stage of the *Roçado de Várzea* Agroforestry System

Figure 5. The Second Stage of *Roçado de Várzea* Agroforestry, Showing a Mixture of Annual and Biannual Crops and Fruit Trees

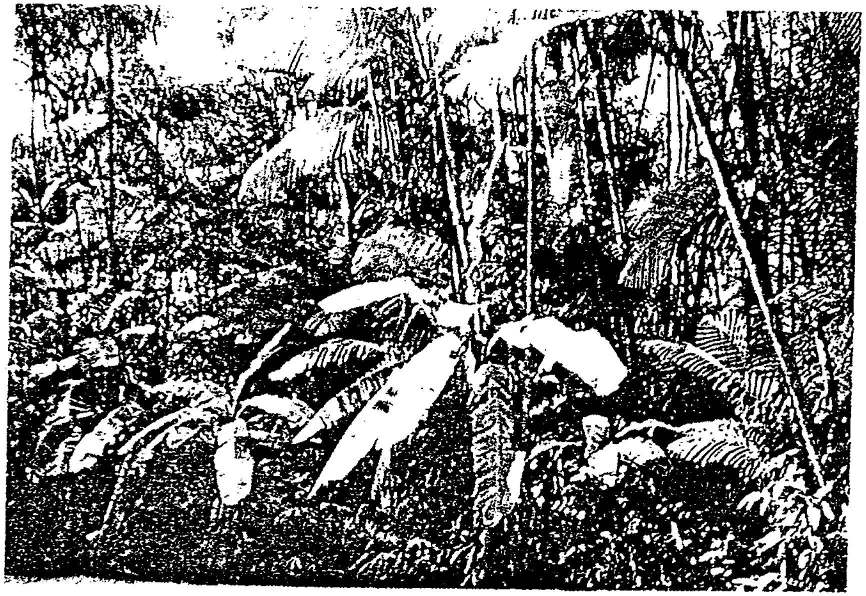

Figure 6. The Third Stage of *Roçado de Várzea* Agroforestry, Showing the Gradual Aging of Bananas and Other Fruits

in particular arrangements. In addition to annual and biannual species, perennial fruit trees, spices, and medicinal species are planted, such as coconut, papaya, peach palm, orange, lime, cupuaçu, breadfruit, and cacao, among others. By the end of the first year, a rich diversity of economic species is in place.

The first products of a *roçado* are the annual species that begin producing after the second month, such as pumpkin and cucumber. Three to four months later, annual crops such as maize and sesame are producing. In both cases, most of the yield is consumed by the producing households and the surplus is taken to the market. Six months after planting, banana and sugarcane begin to dominate ground cover, although some other species are still producing. By the end of the first year, banana, sugarcane, and pineapple begin producing. The overall structure of the *roçado* is characterized by the dominance of these species, followed by perennial trees. After the first year, açaí seedlings begin to grow in the understory of the banana stand, which shows the first signs of the next stage of agroforestry, characterized by trees. Producers usually encourage açaí seedlings during this period by weeding around them. Açaí seeds are both randomly sown and planted in specific spots. Açaí colonization is strengthened by dispersion of seeds from neighboring *açaízais*, mainly during high flooding, which occasionally reaches the *roçado*.

Between the first and second years, the producer harvests a wealth of bananas, sugarcane, and pineapples (see Figure 6). Although these crops will continue producing over the next three years, productivity will fall drastically after açaí overtakes the canopy and shadows other species. As the end of the second year approaches, açaí begins to outdo the banana in height and to dominate the area. After the third year, açaí starts to become clearly dominant and overshadows banana and sugarcane. Açaí production begins within three-and-a-half and five years of the establishment of the *roçado*, when other fruit species such as coconut, cacao, and cupuaçu begin producing as well. At the end of five years, the *roçado* already has the structure and composition of açaí agroforestry (see Figure 7). Pruning is carefully carried out during this period to balance açaí clumps, usually characterized by a wealth of offshoots. When the *roçado* is completely developed and carefully maintained and managed, it has a high density of açaí clumps and a relatively clear understory where fruit trees can be seen.

The development of a *roçado*, thus, imitates the stages of secondary regrowth while creating an economically productive agroforestry that can be maintained for decades. Hardwood species for household use that also have market value, such as *Virola surinamensis*, are generally maintained during weeding and thinning, thus increasing the value of the area. The technique of managing *roçados* represents one of the most important strategies of floodplain agricultural intensification for the region, with the potential for providing for household consumption and representing income and increased property and resource value, while providing output for market.

Figure 7. The Fourth Stage of *Roçado de Várzea* Agroforestry, Showing the Dominance of Açaí Palm in Relation to Other Species

Defining Levels of Management Intensity

Intensification of production systems on the Amazonian floodplain has been frequently associated with deforestation and an increase in energy input and labor to a given area. This approach has frequently contributed to a biased analysis of locally developed agroforestry systems. Agroforestry systems that mimic native forest are "invisible" in the analysis of most researchers, who employ conventional measures of intensification. The result is agroforestry's characterization as extensive, partially extractivist, and nondependent on labor and energy input other than for "gathering."

Defining intensification parameters for locally developed agroforestry systems is a challenge that requires analysis at different levels. While site-specific data on vegetation structure, composition, and development can reveal the degree to which intensification is taking place, it frequently fails to show the spatial particularities associated with it. By nature, the floodplain is not an indivisible tract of land where expansion occurs in a homogeneous fashion. Rather, it resembles a network of sites where different levels of intensification are present, composing a mosaic of more intensively managed sites interconnected by less intensive areas.

Management can be characterized by a series of outcomes on site composition and structure. One can perceive such changes by looking at species arrangement, stand height, density of individuals, and basal area distribution. The unmanaged floodplain forest areas contained 44 or 45 significant tree species, while the number of species in açaí agroforestry varies from 11 to 28—a clear change towards a concentration of economically valuable species. In an unmanaged floodplain forest, the açaí importance value[7] lies between 18 and 30 percent, whereas it rises to around 70 percent in intensively managed açaí agroforestry areas. A jump in importance value occurs soon after management starts and seems to reach a top value after five years of management. Table 1 shows the importance values of açaí increasing as species diversity declines with increased management. The more managed the floodplain forest, the fewer the number of species with DBH (Diameter at Breast Height) greater than 10 cm and the greater the dominance and importance value of açaí. In structural terms, there is a decrease in the average canopy height from 19.0m to 16.5m and a change in first stem height from 12.4m to 10.0m. However, considerably taller trees still occur in agroforestry areas. The vigor of biomass, represented by basal area,[8] also confirms the variation between unmanaged floodplain forest and açaí agroforestry (Table 1). In floodplain forest, açaí contributes less than 15 percent (< 10% in one case) to total stand basal area and represents less than 20 percent of total individuals. As management proceeds, açaí contribution tends to increase to 50 percent of total basal area and up to 90 percent of total number of individuals. Interestingly enough, management does not radically change standing biomass, but rather, the particular species that contribute to it. Thus, it is possible to achieve intensification of management and production without disrupting the structural-functional characteristics of the forest.

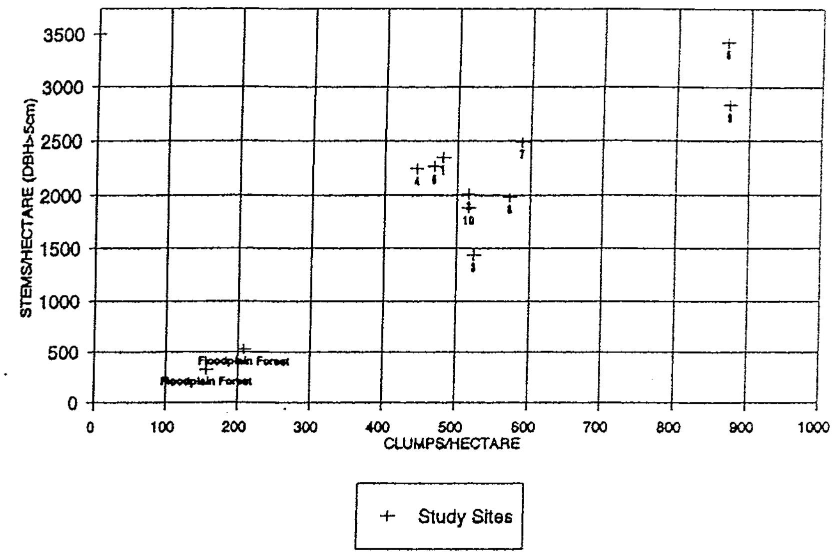

Figure 8. The Density of Açaí Stems and Clumps per Hectare at Study Sites Near the Town of Ponta de Pedras, Pará

In this study, we have argued that yield of an agroforestry stand is the key indicator of agricultural intensification in these systems. This criterion has led us to ground our analysis of management levels upon the dominance of the production unit of açaí agroforestry, that is, the açaí clumps and stems. We also propose the use of two main sets of intensification parameters associated with it. The first is a measure of the density of açaí clumps and stem per hectare. The second is a function of management practices on the production units, such as average height, number of stems per clump, and the contribution of açaí stems to overall site structure and floristic composition. Therefore, management should be seen as a combination of these parameters. This is important because production does not respond only to density of production units but also to the level of maintenance of each unit. For instance, a site with high açaí density but characterized by excessively tall or old stems and an unbalanced number of stems per clump may have the same yield as a lower-density site with well-managed production units.

Density of stems and clumps is the main indicator of management level, since it reflects the dominance of the production unit in an area.[9] At our study sites in Ponta de Pedras (Table 1), density of clumps and stems per hectare can be aggregated into three main levels: low density, medium density, and high density (see Figure 8). Low density is generally found in floodplain forests, whereas medium and high densities are present in intermediate and intensively managed areas. Under low density conditions, there is an average of 150 clumps (450 stems) per hectare, while this number can increase up to nine times in managed areas. Most of the

Table 3. Açaí Production Experiments: Summary

Sites	*Years of Management*	*Number of Species*	*Açaí Clumps per Hectare*	*Açaí Fruit Yield (kg/ha)*	*Yield in Baskets per Hectare*[a]
1	Unmanaged	31	256	1,392	116
2	10	6	656	3,568	297
3	10	5	1,216	12,240	1,020
4	5	6	896	8,904	742
5	1	14	736	2,612	217
6	2	8	1,200	6,476	540
7	1	7	656	2,984	249
8	2	7	608	3,788	315

[a] 1 basket = 11-12 kg

study sites lie in the medium density class, that is, with an average of 500 clumps and 2,000 stems per hectare, but the more intensively managed sites present more than 800 clumps and 3,000 stems per hectare. Medium density agroforestry areas can be achieved after five years of management and maintained over the years. It is likely that the maintenance of productive clumps at such a density requires less labor input than highly dense areas, while achieving substantial production.

Açaí Fruit Production

The production pattern resulting from the experimental sites (Table 3) closely corresponds to the patterns found in relation to level of management at the sites, discussed earlier (Table 1). The three basic groups of açaí agroforestry associated with clump density can thus be related to output production. Group 1 (site 1 only), occurring in unmanaged sites, evidences 256 clumps/ha. In this group, yield is around 1,392 kg/ha/yr, that is, an average of 116 açaí baskets/ha. Group 2 (sites 2, 5, 7, 8), occuring in initially and intermediately managed sites, average 608-736 clumps/ha. In this group, yield varies between 2,612 and 3,788 kg/ha/yr, i.e., an average of 269 açaí baskets/ha. Finally, Group 3 (sites 3, 4, 6), typifying more intensively managed sites, average 896-1,216 clumps/ha. In this group, production varies more widely, from 6,476 to 12,240 kg/ha/yr, or an average of 767 açaí baskets/ha. The typically large standard deviation in this group occurs because, within the same density group, other variables are likely to influence yield, such as years of management (compare sites 6, 4, an 3 in Table 3), level of care in each production unit (pruning, weeding, and planting), and yearly variation in production. Also, the same area is likely to oscillate in production from year to year.[10]

Estimation of the economic return of açaí fruit must take into account price variation during the harvesting season[11] (Brondízio & Safar n.d.). Price is usually low during the first half of the season, due to an abundant market supply. During this period, price of an açaí basket ranges from U.S.$0.80 to U.S.$1.20. This price increases up to sixfold by the end of the season, and it may be as much as tenfold

Table 4. Productivity and Economic Return of Major Crops

Crops	*Location*	*Data Source*	*Productivity (kg/ha)*	*Calories Yield per Hectare*[a]	*Economic Return (US$/ha/year)*[b]
Rice	Floodplain	Lima (1956)	4,500	15,556,500	900
Maize	Floodplain	Lima (1956)	600	2,179,800	180
Beans	Floodplain	Lima (1956)	550	1,870,000	319
Rice	Upland	POEMA (1994)	1,500	5,185,500	300
Maize	Upland	POEMA (1994)	600	2,179,800	180
Beans	Upland	POEMA (1994)	802	2,726,800	460
Manioc	Upland	Brondízio (1996)	12,000	10,266,840	960
Açaí (unmanaged)	Floodplain	Brondízio (1996)	1,390	1,267,680	150-200
Açaí (intermediately managed)	Floodplain	Brondízio (1996)	2,612	2,918,400	300-500
Açaí (intensively managed)	Floodplain	Brondízio (1996)	6,476	8,390,400	700-1,200

[a] Based on Franco (1987). Manioc yield is the average productivity of manioc flour.
[b] Average price in December 1994 (field data).

higher during the winter season. The economic return of açaí fruit is quite dependent on the producer's ability to place his harvest on the market during the period of higher prices. This ability is much reduced for sharecropper caboclos, who depend on the landowner's decision to harvest during a specific period. In the experimental sites, the economic return of fruit production was measured by taking price variation into account during the season; return was calculated according to the percentage of production placed on the market each month (from September to February), less the cost of transportation to market.

In agroforestry areas of low clump density, the net return ranged between U.S.$150 and U.S.$200/ha/year, while net return in areas of medium clump averaged U.S.$300-500/ha/year, and in areas of high clump density, U.S.$700-1,200/ha/year. However, in all cases, the economic return depends on harvesting schedule in relation to price fluctuation during the harvesting season. Therefore, returns may be twice or three times higher if most of a producer's yield is sold in the second half of the harvesting season.

Comparison of açaí production and the economic return of other crops puts this agroforestry system in perspective (Table 4). Compared to other floodplain crops, such as maize, rice, and beans, açaí produced under intensively managed agroforestry is one of the most productive, comparable only to rice and manioc and returning twice as much as beans and maize. However, if production costs are taking into account, rice will show a smaller net return. Intermediately managed açaí agroforestry provides a similar income to beans and maize farming in the floodplain. Most interesting, however, is the outstanding return provided by manioc (after processing into flour), which is greater than that for floodplain rice.

In caloric terms, rice, manioc (processed into flour), and intensively managed açaí are the most productive crops. Açaí agroforestry areas may yield as much as six times more açaí fruit than floodplain forest areas. It is important to note that açaí fruit and manioc flour make up more than 50 percent of the total caloric intake of the average rural household, while rice is not a significant item in the caboclo diet (Siqueira & Murrieta n.d.). The productivity and high economic return of açaí fruit, in addition to its nutritional importance, indicate the significance of this crop for caboclo households and the region as a whole.

DISCUSSION

Application of Intensification Models to Agroforestry Systems

The application of conventional measures of intensification to Amazonian agriculture and agroforestry is hampered by numerous constrains. These limitations are not unique to the study region; they are germane to most small-scale agriculture in the tropics. A primary problem is the focus on a single agricultural activity instead of land use systems into which an agricultural field fits as part of a larger economic/subsistence strategy. This statement brings us back to two ideas discussed above: (1) the importance of seeing agriculture within a spatial context, and (2) the co-existence of intensification and deintensification of agriculture as part of a larger land use strategy (Netting 1993, Guillet 1987). These points can be illustrated by a large body of literature on Amazonian floodplain populations showing more intensive use of the floodplain associated with extensive (i.e., less intensive) swidden in the upland, both correlated with other economic activities, such as fishing, extractivism, hunting, and cattle ranching (Meggers 1971, Moran 1989, Roosevelt 1989, Denevan 1984, Hiraoka 1985, Padoch 1989, Brondízio et al. 1994a, McGraph et al. 1994, Chibnik 1994, Brondízio 1996).

The most problematical application of intensification models concerns agroforestry activities, especially in cases such as açaí agroforestry, where the differences between agroforestry systems are the result of management and planting, and where unmanaged forest is generally overlooked in agricultural analysis. Intensification models are inadequate to evaluate açaí and other agroforestry production systems, due to five main issues: forestry structure, technology, spatial dimensions, "hidden harvest," and floodplain cycles, explained below.

Forest Structure

The most serious constraint on an understanding of açaí agroforestry using conventional measures of intensification concerns forest structure and frequency of production. This constraint arises because this system does not fit into intensification measures, such as Boserup's (1965) "frequency model," which designated the clearing of forest and fallow areas as the beginning of the production process. Indeed, açaí agroforestry may be assigned to both extremes of Boserup's model. In the first place, management of floodplain forest does not replace forest with bare soil. In other words, it does not follow the conventional agricultural path of deforestation-crop-fallow commonly used to assess intensification in a production system. Rather, management transforms forest *into* forest, changing not its ecological structure and function but the dominance and diversity of economically desirable species. As a result, an açaí stand resembles (to an outsider) an ordinary forest and not an agricultural site. There is no category such as food-productive forest in conventional intensification models and, for this reason, an açaí agroforestry area may be characterized as "unproductive land" or, as is commonly said in the region, as extractivist forest.

A planted açaí agroforestry area (i.e., one derived from a *roçado de várzea*), as described earlier, may be characterized as one of the most intensive extremes of Boserup's (1965) frequency model. A *roçado de várzea* produces short-cycle crops (e.g., rice, maize, squash) during the first months, continues with annual and bi-annual crops (e.g., banana, sugarcane, pineapple), and then produces a smaller quantity of fruit trees (e.g., *pupunha*, citrus, coconut) and larger quantities of açaí fruit. Production in this area may be continual and uninterrupted in the long term—as long as management is maintained. In other words, this production system fits neatly into the more intensive, multi-cropping category of Boserup's (1965) model. In mature açaí agroforestry, however, one cannot discern whether the stand results from forest management or whether it is an advanced stage of a *roçado de várzea*. Thus, application of Boserup's (1965) model to define intensification of açaí agroforestry is highly paradoxical, placing it at both extremes of intensification—continual cropping and non-cropping—and failing to incorporate its long-term efficiency and productive capacity, which are the result not of high technological, labor, and capital inputs but, instead, of locally developed management technology.

Technology

It is commonly said that caboclos have inherited the agricultural knowledge of pre-Colombian populations with regard to floodplain agriculture (Moran 1989, Hiraoka 1992). Even if that is true, their application of this knowledge has been shaped by both historical factors (e.g., extractivistic economy) and available market opportunities. Açaí agroforestry is part of this process. As a result of increased rural migration to urban centers, the demand for açaí fruit has increased exponentially in the last 25 years, creating a prosperous market for the fruit. The widespread natural occurrence of açaí palm in the floodplain, associated with its great productivity, makes açaí highly responsive to management. Management occurs at the species level, gradually affecting the vegetation as a whole, making these areas hardly distinguishable from floodplain forest to an outsider. Açaí producers have managed, concurrently, natural populations in floodplain forest and intensively planted açaí palm in floodplain areas (i.e., *roçado de várzea*) in conjunction with annual and perennial crops. The relatively low labor requirement of such techniques, with virtually no specialized tools, characterizes it as a technologically very simple system when compared to conventional horticultural production, for instance.

In general, a *roçado de várzea* follows a development similar to forest succession by starting with annual crops interplanted with a few slower growing species of fruit and native trees. This production system combines the functional and structural characteristics of the forest with economic returns of agroforestry. During the first three years, the area produces grains, tubers, and fruits uninterruptedly, until they are replaced by a mature açaí stand that shades out other species. Once an açaí agroforest is in place, its production will be continual as long as appropriate management is maintained—not only of açaí fruit, but of heart of palm, as well. Only axes and machete are used to prepare and maintain these areas but, while technologically simple, this process involves highly specialized knowledge about the species and vegetation-soil interactions. Therefore, any account of the technological input in this systems cannot rely simply on a comparison with energy-intensive agricultural technology, but should include considerations of accumulated management knowledge, specialized labor, efficiency of production, and sustainability.

Spatial Dimensions

The spatial distribution of açaí agroforestry consists of a complex patchwork of production sites interconnected by both managed and unmanaged forest. Intensively managed and planted açaí agroforestry may be perceived as a result of the dominance of açaí palm. However, areas under management as well as transitional *roçado de várzea* (e.g., from annual to perennial crop) tend to be confused with unmanaged forest or secondary succession. Therefore, assessment of the management intensity of açaí agroforestry cannot be achieved through site-specific inventory alone, but must incorporate analysis of the spatial dimensions and interrelationships between areas under different levels of management.

Three levels of management have being described in relation to both site-specific structure and spatial arrangement: unmanaged, intermediately managed, and intensively managed (including planting areas resulting from *roçado de várzea*). These levels are not only a measure of the density of açaí clumps and stems in an area, but also reflect their spatial extent. Unmanaged areas are generally contiguous stretches of floodplain forest, which, structurally and functionally, are not dominated by açaí palm, but where açaí may be a prominent species. In contrast, intensively managed agroforestry areas are clearly dominated by açaí palm. Defining the intermediary level of management requires an understanding of both site-specific dominance of açaí palm and the spatial connections between intensively managed and unmanaged areas. In short, intermediately managed areas consist of sites of intensively managed areas that are neither contiguous nor continuous, but which are interconnected by unmanaged forest. Thus, intermediately managed areas indicate a progressive expansion of intensively managed areas that become interconnected as management proceeds. Although site-specific assessment can reveal the level of management applied to change the structural characteristics of the vegetation, it affords only limited insight into how intensification of management proceeds in spatial terms. In summary, such a pattern of progressive expansion of intensive sites poses a challenge to straightforward measures of intensification based on input (energy, labor, capital) per unit of area and to measures of crop frequency based on the contrast between productive and non-productive areas.

"Hidden Harvest"

The subsistence economy of tropical agriculturalists involves more than edible products (Ellen 1982). The literature on non-timber products of tropical forests has flourished in the last few years, as has the search for alternatives to deforestation and for better knowledge of local economic strategies (Plotkin & Famolare 1992, Nepstad & Schwartzman 1992, Hecht et al. 1988, Lescure et al. 1994). Although sometimes considered almost impossible, taking into account the whole range of agroforestry products is fundamental to understanding the relevance of these areas in terms of supplying the household with food, raw materials, and medicine, and providing market opportunities sometimes even more lucrative than market crops. A good example is Hiraoka's (n.d.) work in the estuary, showing the importance of miriti (*Mauritia flexuosa*) to household income. There, the marketing of miriti fruit represents 13-15 percent of total household income.

Secondary output of açaí agroforestry involves both household and market products with variable values. Raw materials such as fibers and stems, used in building houses and fish traps, contrast with highly valuable hardwood. Although the market value of hardwood may be easily assessed, such assessment is much harder for non-timber products. Nevertheless, studies have shown that these latter account for a considerable part of the local economy, and in some cases they may exceed other activities, such as agriculture and ranching (Peters et al. 1989, Hecht 1992). In summary, access to a large portfolio of timber and non-timber products present in agroforestry areas increases market independence in terms of raw materials and constitutes an important part of both household and market economy that should be considered when accounting for agroforestry productivity.

Flooding Cycles

Another contradiction in the use of Boserup's (1965) model to define the intensification of floodplain agriculture is noted by Chibnik (1994), based on his work in the Peruvian Amazon. He noted that the cropping frequency model does not fit the floodplain cycles, since agriculture is regulated by the seasonal rise and fall of rivers. In addition, production in these areas varies yearly largely due to environmental conditions, rather to variation in technological and labor inputs. This variation is less of a problem in the estuary, where flooding is regulated by the daily tides, but it is true for most of the Amazonian floodplain, which is seasonally flooded. In summary, the comparison of cropping frequencies is not adequate in this circumstance, and even yield needs to be considered as a variable less dependent on technology and capital input and more strongly dependent on environmental variables, such as annual rain or flood pattern.

OVERCOMING CONTRADICTIONS: CABOCLOS AS RURAL PRODUCERS

In the context of creating a new economic development concept based on social justice and environmental grounds, it is important to modify our conception of caboclos as a social category. In this sense, Netting's (1993) contribution is enormous. Although he avoids the term "peasant," probably because of the negative connotation attached to the concept, he has contributed to redefining peasant categorization by calling attention to the important role peasant farming plays in the world's agriculture. The characteristics pointed out by Netting (1993) to typify the smallholder are useful for understanding the analytical concept of "peasant." Peasants are a rural population; they produce for themselves but also produce for the market; their economy depends on family labor, but they often employ themselves off their farms in a market economy and employ others as needed; they are not specific to any historical time or geographic place, i.e., they existed before capitalism and probably will exist "after" it in different parts of the world. As a social category, they are not "inexorably" doomed to disappear, nor they are a homogeneous group. The social, cultural, and environmental diversities of this social category must be recognized and taken to account. As rural producers, they are an important social category of contemporary societies and, as such, they need to be recognized, especially by the political authorities who control the economic and development policies in rural areas.

In summary, redefining caboclos' identity as rural producers in the sense of Netting's (1993) small farmer is an important step towards overcoming the prejudices entailed by the very term "caboclo." Recognizing the role they play in regional agriculture and food production may contribute to a shift from seeing their production system as extractivist toward seeing it as nothing less than forest farming.

ACKNOWLEDGMENTS

This study was made possible by a grant from NASA's Global Change Fellowship Program to the "Land Use Change in the Amazon Estuary: Agriculture, Secondary succession and Agroforestry of Native Populations" project (E. Brondízio, Principal Investigator, NASA 3708-GC94-0096). Earlier work in the area was supported by the National Science Foundation's Geography and Regional Science program and the Program on the Human Dimensions of Global Environmental Change (Emilio Moran, Principal Investigator, NSF91-00526)). Earlier field studies in the area, informing this work, were made with support from the Wenner-Gren Foundation for Anthropological Research to E. Moran and grants from the Brazilian National Research Council and the Museu Goeldi in Brazil (Walter Neves, Principal Investigator, CNPq 403534/90-9; 150043/90-2). We are equally thankful to CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for providing Siqueira with a doctoral scholarship between 1991 and 1995 (CNPq 201076/91-8). We are also grateful for the support (infrastructure and personnel) of the Anthropological Center for Training and Research on Global Environmental Change at Indiana University.

We especially acknowledge the assistance and friendship of the açaí producers who collaborated with the production experiments and who taught us about floodplain agriculture and agroforestry management. We are grateful to Emilio Moran for his support and advice during all stages of this study, and to Richard Wilk, who opened the "windows" of economic anthropology for us. We are equally grateful to our colleagues Rui Murrieta and Walter Neves. We acknowledge the assistance of the late Lucival Rodrigues Marinho and of Jair da Costa Freitas with plant taxonomy and vegetation inventory. We are equally thankful to Mário Jardim for his suggestions on the açaí production experiments. We are indebted for local support to our friends, Valois Delcastagne and Socorro V. Ribeiro, and to the people of the communities of Praia Grande, Marajó-açu, Paricatuba, and Ponta de Pedras as a whole. Finally, we are grateful for the collaboration of Priscila, during the writing of this paper. At the same time, the views expressed in this paper are our sole responsibility and do not necessarily reflect the views of the funding sources or collaborators.

NOTES

1. FIBGE (Fundação Brasileira de Geografia e Estatística) defines vegetal extractivism thusly: "It is the process of exploring natural vegetation resources that comprises gathering or harvesting of products such as wood, latex, seeds, fibers, fruits, and roots, among others, via rational means, allowing a sustainable production over time or, in primitive and itinerant form, allowing, usually, a single harvest" (our translation). The limits of the term extractivism for characterizing açaí agroforestry have been briefly discussed in the studies of A.B. Anderson et al. (1985) and Anderson (1990, 1992) in the estuary.
2. We concentrate our analysis on the forested areas of the estuary, but it is important to point out that cattle ranching on Marajó's grasslands is of major significance, as is fishing in the estuary.
3. Anderson et al. (1993) estimate that *Virola suranimensis* industry generates an economy of US$ 50 million/year; a government publication, *Pará Rico por Natureza* (1993) estimates that expor-

tation of heart of palm in Pará is responsible for an economy of U.S.$30 million. However, taking into account all the sectors of the heart of palm industry, Pollack et al. (1994) estimated that it alone contributes approximately US$ 300 million to the estuarine economy.

4. The quality of açaí fruit production data provided by FIBGE is highly suspect. Among the problems is the reliance on data from Belém's market and the lack of systematic data collection in Belém and other parts of the estuary. To our knowledge, there are no systematic daily and seasonal surveys of açaí market and production fluctuations; another problem is the informality of the sector, which makes it barely quantifiable by traditional statistical methods. However, FIBGE data can be of practical use in understanding the growth pattern associated with the açaí fruit economy and the overall figures of açaí production in the region. Data on heart of palm are expected to be more precise, since this product is highly controlled by industries and distributors, and it is an important export product for the state of Pará.

5. During the last decade, the state of Maranhão has also been increasing its participation in the market, including Belém. Ponta de Pedras is responsible for around 30 percent of total production, which makes it the main supplier of fruit. However, during the last decade other municipalities in the estuary, such as Cametá and Abaetetuba, have made a greater contribution. Of equal importance is the participation of the estuarine islands (região das ilhas), especially those located near Belém.

6. These figures assume that the average price of an açaí basket (around 12 kg) in the estuary equals U.S.$1.60. The cost of transportation corresponds to 7-10 percent of total basket price. Açaí market brokers work with a 25 percent profit margin on each basket. The average juice production of one açaí fruit basket is 6 liters. The average price of one liter of açaí juice equals U.S.$2.00. This does not take into account the amount and the economic significance of açaí consumed directly by riverine households.

7. Importance value is a index calculated by averaging relative density (abundance), relative frequency (spatial distribution), and relative dominance (biomass) of a species in a given vegetation stand, providing a means of balancing the different characteristics of a species in the plant community.

8. Basal area is the cross-sectional area possessed by a tree trunk. DBH (Diameter at Breast Height) is the most pratical way of assessing basal area. Basal area is one of the most widely used indicator of species dominance (i.e., biomass).

9. There are different accounts of stem and clump density for different areas of the estuary. Calzavara (1972) reports areas of heart of palm (and açaí fruit) production with the highest densities among all accounts. In an experiment, he describes the occurrence of more than 9,000 stems per hectare, divided roughly equally between small, medium, and large stems. Assuming the figure of approximately 5 to 6 stems per clump, we would find up to 1,500 clumps per hectare under such conditions. Hiraoka (1994) describes an average of 600 to 650 clumps per hectare in Abaetetuba. Jardim & Kageyama (1994) describe a population of 232 clumps and 540 stems at a 1.5 ha site in Combu Island in an unmanaged area. Lopes et al. (1982) report an average of 600 stems per hectare in an unmanaged floodplain forest, and about 625 clumps and 3,750 stems per hectare in a managed forest. Jardim & Anderson (1987) describe different densities, depending on management strategies; they found that management can increase clump density up to 50 percent. The same situation is described in Anderson (1990), who notes that an area of 0.25 ha in unmanaged forest may have 100 clumps (around 400/ha), and a managed forest, 163 clumps (around 652/ha). It is important to note, however, that both of these accounts seem to focus only on the first two years of management.

10. Some comparisons can be made between the production figures from Ponta de Pedras experimental sites and other sites reported in the literature. For instance, considering the number of clumps/ha (between 131 and 200) presented by Jardim and Anderson (1987), yield is consistent between the two studies. While their estimates range from 1,158 to 2,437 kg/ha/yr, this work presents an average of 1,390 kg/ha/yr for the same density of clumps. The same analogy seems to be true of the work of Peters (1992). Compared to Hiraoka's (1994) work, however, similar density of clumps (550—650/ha) correlated with lower output production in Ponta de Pedras. While he estimates an average production of 8,250 kg/ha/yr, we found an average of 3,200 kg/ha/yr in areas of similar clump density. However, it

should to be considered that Hiraoka's estimate is derived using the assumption of average production of açaí baskets per hectare (approximately 550) and on an average basket weight of 15 kg. As mentioned before, the average basket weight measured in Ponta de Pedras was 11.3 kg, not 15 kg. By changing this figure, his estimate drops from 8,250 to 6,215 kg/ha/yr, a figure closer to that of Ponta de Pedras. There are no data available to compare highly intensive sites, that is, those with clump densities greater than 900 individuals/ha. At this level, the data indicate an average production of 9,206 kg/ha/yr, a figure similar to that initially presented by Hiraoka. This suggests that Hiraoka's data may come from intensively managed sites.

11. The production season starts generally in August or September and streaches until late January or February, depending on the year. This period is called summer harvesting season. A winter harvesting season of much less intensity occurs between March and June. Winter season, although less productive, is very important for ensuring household supply of fruit; it also provides an additional income, due to the high market price of açaí during this time. The standard measure of açaí fruit is the basket, locally called "paneiro." A basket correspond to about 12 kg of fruit.

REFERENCES

Allan, W. (1949) *Studies in African Land Usage in Northern Rhodesia*. Cape Town: Oxford University Press, Rhodes-Livingston Paper No. 15.

Altieri, M.A., and S.B. Hecht (1990) *Agroecology and Small Farm Development*. Boston: CRC Press.

Anderson, A.B.(1987) "Use and Management of Native Palm Forest." Pp. 45-62 in H.L. Gholz (ed.), *infra*.

——— (1988) "Use and Management of Native Forests Dominated by Açaí Palm (*Euterpe oleracea*) in the Amazon Estuary." *Advances in Economic Botany* 6:144-154.

———, ed. (1990) *Alternatives to Deforestation: Steps Toward Sustainable Use of the Amazon Rain Forest*. New York: Columbia University Press.

——— (1991) "Forest Management Strategies by Rural Inhabitants in the Amazon Estuary." Pp. 157-168 in A. Gomez-Pompa, T.C. Whitmore & M. Hadley (eds.). *Rain Forest Regeneration and Management*. Paris: UNESCO, Man and Biosphere Series, Vol. 6.

——— (1992) "Land Use Strategies for Successful Extractive Economies in Amazonia." Pp. 67-78 in D.C. Nepstad & S. Schwartzman (eds.), *infra*.

Anderson, A.B., and E. Iorys (1992) "The Logic of Extraction: Resource Management and Income Generation by Extractive Producers in the Amazon Estuary." Pp. 175-199 in K. Redford & C.Padoch (eds.). *Conservation of Neotropical Forests*. New York: Columbia University Press.

Anderson, A.B., and M.A.G. Jardim (1989) "Costs and Benefits of Floodplain Forest Management by Rural Inhabitants in the Amazon Estuary: A Case Study of Açaí Palm Production." Pp. 114-129 in J.O. Browder (ed.) *Fragile Lands of Latin America*. Boulder, CO: Westview Press.

Anderson, A.B., and D.A. Posey (1989) "Management of a Tropical Scrub Savanna by the Gorotire Kayapó Indians." *Advances in Economic Botany* 7:159-173.

Anderson, A.B., A. Gely, J. Strudwick, G.L. Sobel, and M.G.C. Pinto (1985) "Um Sistema Agroforestal na Várzea do Estuário Amazônico (Ilha das Onças, Município de Barcarena, Estado do Pará)" ("A Floodplain Agroforestry System in the Amazon Estuary [Onças Island, Barcarena County, State of Pará]"). *Acta Amazonica* 15:195-224.

Anderson, A.B., I. Mousasticoshvily, and D.S. Macedo (1993) *Impactos Ecológicos e Sócio-Econômicos da Exploração Seletiva de Virola no Estuário Amazônico* (*Ecological and Socioecomonic Impacts of Selective Exploitation of Virola in the Amazon Estuary*). Brasília: World Wildlife Fund.

Anderson, R.L. (1976) *Following Curupira: Colonization and Migration in Pará 1758-1930 as a Study in Settlement of the Humid Tropics*. Ph.D. dissertation, University of California, Davis.

Anderson, S.D. (1992) "Engenhos de várzea: uma análise de declínio de um sistema de produção tradicional na Amazônia" ("Floodplain Sugarcane Mills: An Analysis of the Decline of a Traditional Production System in Amazonia"). Pp. 101-124 in P. Léna & A.E. Oliveira (eds.) *Amazônia: A Fronteira Agrícola 20 Anos Depois*. Belém: CEJUP.

Ayres, D.M. (1992) *History, Social Organization, Identity and Outsiders'Social Classification of the Rural Population of Amazonian Region*. Ph.D. dissertation, King's College, Cambridge University.

Balée W., and A. Gely (1989) "Managed Forest Succession in Amazonia: The Ka'apor Case." *Advances in Economic Botany* 7:129-158.

Bates, H.W. (1988) *The Naturalist on the River Amazons*. New York: Penguin Books. [first published in 1863]

Beckerman, S. (1979) "The Abundance of Protein in Amazonia: A Reply to Gross." *American Anthropologist* 81:533-560.

______ (1983) "Does the Swidden Ape the Jungle?" *Human Ecology* 11:1-12.

Behrens, C.A., M.L. Baksh, and M. Mothes (1994) "A Regional Analysis of Bari Land Use Intensification and Its Impact on Landscape Heterogeneity." *Human Ecology* 22:279-316.

Boserup, E. (1965) *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Chicago: Aldine.

Boster, J. (1983) "A Comparison of the Diversity of Jivaroan Gardens with that of Tropical Forest." *Human Ecology* 11:47-68.

Brondízio, E.S. (1996) *Forest Farmers: Human and Landscape Ecology of Caboclo Populations in the Amazon Estuary*, Ph.D. dissertation, Indiana University, Bloomington.

Brondízio, E.S., et al. [E.F. Moran, P. Mausel, Y. Wu] (1993a) "Padrões de Assentamento Caboclo no Baixo Amazonas: Análise Temporal de Imagens Landsat TM Como Suporte Aos Estudos de Ecologia Humana na Amazônia" ("Caboclo Settlement Patterns in the Lower Amazon: Temporal Analysis of Landsat TM Images as Support for Studies of Human Ecology in Amazonia"). Curitiba, Paraná: *7º Simpósio Brasileiro de Sensoriamento Remoto* (7th Brazilian Symposium on Remote Sensing) 1:16-26.

______ (1993b) "Dinâmica da Vegetação no Baixo Amazonas: Análise Temporal do Uso da Terra Integrando Imagens Landsat TM, Levantamento Florístico e Dados Etnográficos" ("Vegetation Dynamics in the Lower Amazon: Integrating Landsat TM, Floristic Inventory, and Ethnographic Data in a Temporal Analysis of Land Use"). Curitiba, Paraná: *7º Simpósio Brasileiro de Sensoriamento Remoto (7th Brazilian Symposium on Remote Sensing)* 2:38-46.

______ (1994) "Land Use Change in the Amazon Estuary: Patterns of Caboclo Settlement and Landscape Management." *Human Ecology* 22:249-278.

______ (1996) "Land Cover in the Amazon Estuary: Linking of Thematic Mapper with Botanical and Historical Data." *Photogrammetric Engineering and Remote Sensing* 62:921-929.

Brondízio, E.S., E.F. Moran, A.D. Siqueira, et al. [P. Mausel, Y. Wu, Y. Li] (1994) "Mapping Anthropogenic Forest: Using Remote Sensing in a Multi-Level Approach to Estimate Production and Distribution of Managed Palm Forest (*Euterpe oleracea*) in the Amazon Estuary." *International Archives of Photogrammetry and Remote Sensing* 30:184-191

Brondízio, E.S., and W.A. Neves (1996) "A Percepção do Ambiente Natural por Parte de Populações Caboclas do Estuário do Amazonas: Uma Experiência Piloto Atravéz do Método de Trilhas Pré-Fixadas" ("Caboclos' Perception of the Natural Environment in the Amazon Estuary: A Pilot Experience Using the Methods of Pre-Established Tracks"). Pp. 167-182 in C. Pavan (ed.) *Uma Estrategia Latino-Americana para a Amazônia*, Vol. 1 (*A Latin American Strategy for the Amazon*). São Paulo: Fundação Memorial da América Latina/Editora UNESP.

Brondízio, E.S., and C. Safar (n.d.) "Caboclos' Responses to Marketing: The Case of Açaí Agroforestry in the Amazon Estuary." Paper presented to the American Anthropological Association, San Francisco, November 20-25, 1996.

Brookfield, H.C. (1962) "Local Study and Comparative Method: An Example from Central New Guinea." *Annals of the Association of American Geographers* 52:242-254.

Brush, S.B. (1975) "Concept of Carrying Capacity for Systems of Shifting Cultivation." *American Anthropologist* 77:799-811.

Bunker, S.G. (1985) *Underdeveloping the Amazon: Extraction, Unequal Exchange, and the Failure of the Modern State*. Chicago: University of Chicago Press.

Calzavara, B.B.G. (1972) "As Possibilidades do Açaizeiro no Estuário Amazônico" ("The Possibilities of Açaí Palm in the Amazon Estuary"). *Boletim Fundação de Ciências Agrárias do Pará* 5:1-103.

Carneiro, R. (1960) "Slash-and-Burn Agriculture: A Closer Look at Its Implications for Settlement Patterns." Pp. 229-234 in F.C. Wallace (ed.) *Men and Cultures: Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences*, Philadelphia: University of Pennsylvania Press.

Chibnik, M. (1991) "Quasi-Ethnic Groups in Amazonia." *Ethnology* 30:167-182.

______ (1994) *Risky Rivers*. Tucson: University of Arizona Press.

Clarke, W.C. (1966) "From Extensive to Intensive Shifting Cultivation: A Succession from New Guinea." *Ethnology* 5:347-359.

______ (1976) "Maintenance of Agriculture and Human Habitats Within the Tropical Forest Ecosystem." *Human Ecology* 4:247-259.

Conant, F. (1990) "1990 and Beyond: Satellite Remote Sensing and Ecological Anthropology." Pp. 357-387 in Emilio Moran (ed.) *The Ecosystem Approach in Anthropology: From Concept to Practice*. Ann Arbor: University of Michigan Press.

Conklin, H. (1957) *Hanunoo Agriculture: A Report of an Integral System of Shifting Cultivation in the Phillippines*. Rome: United Nations Food and Agricultural Organization.

______ (1959) "Population-Land Balance Under Systems of Tropical Forest Agriculture." *Proceedings of the Ninth Pacific Science Congress* 7:63-69. Bangkok: Pacific Science Association.

Cunha, E. da (1941) *A Margem da História*. Porto: Lello e Irmão.

Dale, V., R.V. O'Neil, M. Pedlowski, and F. Southworth (1993) "Cause and Effects of Land-Use Change in Central Rondônia, Brazil." *Photogrammetric Engineering and Remote Sensing* 59:997-1005.

Denevan, W. (1984) "Ecological Heterogeneity and Horizontal Zonation of Agriculture in the Amazon Floodplain." Pp. 311-336 in M. Schimink & C.H.Wood (eds.) *Frontiers Expansion in Amazonia*. Gainesville: University of Florida Press.

Devenan, W., and C. Padoch, eds. (1987) *Swidden-Fallow Agroforestry in the Peruvian Amazon*. New York: The New York Botanical Garden (*Advances in Economic Botany* Vol. 5).

Ellen, R. (1982) *Environment, Subsistence and System*. Cambridge, ENG: Cambridge University Press.

Franco, G. (1987) *Tabela de Composição Química dos Alimentos* (*Table of Food Chemical Composition*). Rio de Janeiro: Livraria Atheneu.

FIBGE [Fundação Instituto Brasileiro de Geografia e Estatística] (1974-1989) *Produção da Extração Vegetal e da Silvicultura* (*Production of Vegetable Extract and of Silviculture*). Rio de Janeiro: Departamento Agropecuário, Diretoria de Pesquisas.

Geertz, C. (1963) *Agricultural Involution: The Process of Ecological Change in Indonesia*. Berkeley: University of California Press.

Gholz, H.L., ed. (1987) *Agroforestry: Realities, Possibilities and Potencials*. Dordrecht: Martinus Nijhoff Publisher.

Gourou, P. (1966) *The Tropical World*. New York: Ronald Press.

Guillet, D. (1987) "Agricultural Intensification and Deintensification in Lari, Colca Valley, Southern Peru." Pp. 201-224 in B. Isaac (ed.) *Research in Economic Anthropology, Vol. 8*. Greenwich, CT: JAI Press.

Hames, R., (1983) "Monoculture, Polyculture, and Polyvariety in Tropical Forest Swidden Cultivation." *Human Ecology* 11:13-34.

Hecht, S. (1992) "Valuing Land Uses in Amazonia: Colonist Agriculture, Cattle, and Petty Extraction in Comparative Perspective." Pp. 379-399 in K. Redford & C. Padoch (eds.) *Conservation of Neotropical Forests*. New York: Columbia University Press.

_____ (1993) "The Logic of Livestock and Deforestation in Amazonia." *BioScience* 43: 687-695.

Hecht, S.B., A.B. Anderson, and P. May (1988) "The Subsidy from Nature: Shifting Cultivation, Successional Palm Forests, and Rural Development." *Human Organization* 47:25-35.

Hiraoka, M. (1985) "Zonation of Mestizo Riverine Farming Systems in Northeast Peru." *National Geographic Research* 2:354-71.

_____ (1989) "Agricultural Systems on the Floodplains of the Peruvian Amazon." Pp. 75-99 in J.O. Browder (ed.) *Fragile Lands of Latin America*. Boulder, CO: Westview Press.

_____ (1992) "Caboclo and Ribereño Resource Management in Amazonia: A Review." Pp. 134-157 in R. Redford & C. Padoch (eds.) *Conservation of Neotropical Forests*. New York: Columbia University Press.

_____ (1994) "Mudanças nos Padrões Econômicos de uma População Ribeirinha do Estuário do Amazonas" ("Change in Economic Patterns of a Riverine Population in the Amazon Estuary"). Pp. 133-157 in L. Furtado, A.F. Mello & W. Leitão (eds.) *Povos das Águas: Realidade e Perspectivas na Amazônia (The River Peoples: Reality and Perspectives in Amazonia)*. Belém: MPEG/Universidade Federal do Pará.

_____ (n.d.) "The Use and Management of 'Miriti' (*Mauritia flexuosa*) Palm among the Ribeirinhos along the Amazon Estuary." Paper presented at "Diversity, Development and Conservation of Amazonian Floodplain," Macapá, Amapá, Brazil, Dec. 12-14, 1994.

Homma, A. (1993) *Extrativismo Vegetal na Amazônia: Limites e Oportunidades (Vegetal Extractivism in Amazonia: Limits and Opportunities)*. Brasília, DF: Empresa Brasileira de Produção Agrícola e Agropecuária.

ICRAF [International Research Center for Agroforestry] (1983) *Resources for Agroforestry Diagnosis and Design*. Nairobi: International Research Center for Agroforestry. Working Paper No. 7.

Jardim, M.A.G. (1991) *Aspectos da Biologia Reprodutiva de uma População Natural de Açaízeiro (Euterpe Oleracea) no Estuário Amazonico (Aspects of Reproductive Biology of a Natural Population of Açaí Palm (Euterpe oleracea) in the Amazon Estuary)*. Master's Thesis, Escola Superior de Agricultura "Luiz de Queiróz," University of São Paulo, Brazil.

Jardim, M.A.G., and A.B. Anderson (1987) "Manejo de Populações Nativas de Açaizeiro no Estuário Amazônico: Resultados Preliminares" ("Management of Native Populations of Açaí Palm in the Amazon Estuary: Preliminary Results"). *Boletim de Pesquisa Florestal* 15:1-18.

Jardim, M.A.G. and P.Y. Kageyama (1994) "Fenologia de Floração e Frutificação em População Natural de Açaizeiro (*Euterpe oleracea*) no Estuário Amazônico" ("Flowering and Fructification Phenology of a Natural Population of Açaí Palm in the Amazon Estuary"). *Boletim do Instituto de Pesquisas de Engenharia Florestal* 47:62-65.

Kummer, D.M. and B.L. Turner II (1994) "The Human Causes of Deforestation in Southeast Asia." *Bioscience* 44:323-328.

Lathrap, D. (1970) *The Upper Amazon*. London: Thames & Hudson.

Lescure, J.P., F. Pinton, and L. Emperaire (1994) "People and Forest Products in Central Amazonia: The Multidisciplinary Approach of Extractivism." Pp. 59-85 in M. Clusener & I. Sachs (eds.) *Extractivism in the Brazilian Amazon: Perspectives on Regional Development*. Paris: UNESCO, Man and the Biosphere Digest.

Lima, R.R. (1956) "Agricultura nas Várzeas do Estuário do Amazonas" ("Agriculture in the Floodplains of the Amazon Estuary"). *Boletim Técnico do Instituto Agronômico do Norte* 33:1-164.

Lopes, A.V.F., J.M.S. Souza, and B.B.G. Calvazara (1982) *Aspectos Econômicos do Açaizeiro (Economic Aspects of Açaí Palm)*. Belém: Superintendência de Desenvolvimento da Amazônia.

Mausel, P., Y. Wu, Y. Li, E.F. Moran, and E.S. Brondízio (1993) "Spectral Identification of Successional Stages Following Deforestation in the Amazon." *Geocarto International* 8:61-71.

McGrath, D. (1987) "The Role of Biomass in Shifting Cultivation." *Human Ecology* 15:221-242.

MacGrath, D., F. deCastro, C. Futemma, and B. Domingues (1994) "Manejo de Lagos de Várzea no Baixo Amazonas" ("Floodplain Lake Management in the Lower Amazon"). Pp. 234-243 in L. Furtado, A.F. Mello & W. Leitão (eds.) *Povos das Águas: Realidade e Perspectivas na Amazônia (The River Peoples: Reality and Perspectives in Amazonia)*. Belém: MPEG/Universidade Federal do Pará.

Meggers, B. (1954) "Environmental Limitations on the Development of Culture." *American Anthropology* 56:801-24.

_____ (1971) *Amazonia: Man and Culture in a Counterfeit Paradise*. Chicago: Aldine.

Meggers, B., and C. Evans (1957) *Archeological Investigations at the Mouth of the Amazon*. Washington, DC: Smithsonian Institution, Bureau of American Ethnology, Bulletin 167.

Moran, E.F. (1974) "The Adaptive System of the Amazonian Caboclo." Pp. 136-159 in C. Wagley (ed.) *Man in the Amazon*. Gainesville: University of Florida Press.

_____ (1989) "Models of Native and Folk Adaptation in the Amazonia." Pp. 22-29 in D. Posey & W. Balée (eds.) *Resources Management in Amazonia: Indigenous and Folk Strategies*. New York: The New York Botanical Garden. (*Advances in Economic Botany, Vol. 7*).

_____ (1990) *A Ecologia Humana das Populações da Amazônia (Human Ecology of the Amazonian Populations)*. Rio de Janeiro: Editora Vozes.

_____ (1993) "Deforestation and Land Use in the Brazilian Amazon." *Human Ecology* 21:1-21.

Moran, E.F., et al. [E. Brondízio, P. Mausel, and Y. Wu] (1993) "Assinaturas Espectrais Diferenciando Etapas de Sucessão Secundária no Leste Amazônico" ("Spectral Signatures Differentiating Secondary Succession in Eastern Amazonia"). Curitiba, Paraná: *7° Simpósio Brasileiro de Sensoriamento Remoto (7th Brazilian Symposium on Remote Sensing)* 2:202-209.

_____ (1994a) "Deforestation in Amazonia: Land Use Change from Ground and Space Level Perspective." *Bioscience* 44:329-339.

_____ [E. Brondízio, and P. Mausel] (1994b) "Secondary Succession and Land Use in the Amazon." *National Geographic Research & Exploration* 10:456-476.

Murrieta, R.S.S. (1994) *Diet and Subsistence: Changes in Three Caboclo Populations on Marajó Island, Amazonia, Brazil*. Master's Thesis, University of Colorado, Boulder.

Murrieta, R.S.S., E.S. Brondízio, A.D. Siqueira, and E.F. Moran (1989) "Estratégias de Subsistência de Uma População Ribeirinha da Ilha de Marajó, Brasil" ("Subsistence Strategies of a Riverine Population in Marajó Island, Brazil"). *Boletim do Museu Paraense Emilio Goeldi*, Série Antropologia 5:147-63.

_____ (1992) "Estratégias de Subsistência da Comunidade de Praia Grande, Ilha de Marajó, Brasil" ("Subsistence Strategies of the Praia Grande Community, Marajó Island, Brazil"). *Boletim do Museu Paraense Emilio Goeldi*, Série Antropologia 8:185-201.

Nair, P.K.R. (1990) *The Prospects for Agroforestry in the Tropics*. Washington, DC: World Bank Technical Paper No. 131.

NCR [National Research Council] (1992) *Global Environmental Change*. Washington, DC: National Academy Press.

NASA [National Aeronautics and Space Administration] (1990) *Applications of Space-Age Technology in Anthropology*. Washington, DC: NASA Science and Technology Laboratory, John C. Stennis Space Center Conference Proceedings.

Nepstad, D.C., and S. Schwartzman eds. (1992) *Non-Timber Products from Tropical Forests: Evaluation of a Conservation and Development Strategy*. New York: The New York Botanical Garden (*Advances in Economic Botany, Vol.9*).

Netting, R. (1963) *Kofyar Agriculture: A Study in the Cultural Ecology of a West African People*. Ph.D. dissertation, University of Chicago.

_____ (1965) "Household Organization and Intensive Agriculture: The Kofyar Case." *Africa* 35:422-429.

_____ (1993) *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*. Stanford, CA: Stanford University Press.

Neves, W.A., ed. (1992) *Antropologia Ecológica de Populações Ribeirinhas do Estuário do Amazonas: Subsistência e Adapatação* (*Ecological Anthropology of Riverine Populations of the Amazon Estuary: Subsistence and Adaptation*). Brasília: Relatório Científico, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

Nugent, S. (1993) *Amazonian Caboclo Society: An Essay on Invisibility and Peasant Economy.* Oxford, ENG: Berg.

Nye, P.H., and D.J. Greenland (1960) *The Soil Under Shifting Cultivation.* Harpenden, ENG: Commonwealth Agricultural Bureaux of Soils, Technical Communication No. 51.

Ojima, D.S., K.A. Galvin, and B.L. Turner II (1994) "The Global Impact of Land-Use Change." *Bioscience* 44:300-304.

Padoch, C. (1989) "Production and Profit in Agroforestry Practices of Native and Ribereno Farmers in the Lowland Peruvian Amazon." Pp. 102-114 in J.O. Browder (ed.) *Fragiles Lands of Latin America.* Boulder, CO: Westview Press.

——— (1992) "Marketing of Non-Timber Forest Products in Western Amazonia: General Observations and Research Priorities." Pp. 43-50 in D.C. Nepstad & S. Schwartzman, (eds.) *supra.*

PARÁ (1994) *Pará: Rico por Natureza* (*Pará: Wealthy by Nature*). Belém: Governo do Estado do Pará.

Parker, E. (1985) "Caboclization: The Transformation of the Amerindian in Amazonia, 1615-1800." *Studies in Third World Societies* 32:1-49.

Peters, C. (1992) "The Ecology and Economics of Oligarchic Amazonian Forests." *Advances in Economic Botany* 9:15-22.

Peters, C., A. Gentry, and R. Mendelsohn (1989) "Valuation of an Amazon Rainforest." *Nature* 339:656-657.

Pires, J.M. (1973) "Tipos de Vegetações da Amazonia" ("Vegetation Types of Amazonia"). *Boletim do Museu Paraense Emilio Goeldi* 20:179-202.

Plotkin, M., and L. Famolare, eds. (1992) *Sustainable Harvest and Marketing of Rain Forest Products.* Washington, DC: Island Press.

POEMA [Pobreza e Meio Ambiente na Amazônia] (1994) *Amazônia: Alianças em Defesa da Vida* (*Amazonia: Alliances in Defense of Life*). Belém: Universidade Federal do Pará.

Pollack, H., M. Matos, and C. Uhl (1994) "A Profile of Palm Heart Extraction in the Amazon Estuary." *Human Ecology* 22:145-162.

Posey, D.A. (1985) "Indigenous Management of Tropical Forest Ecosystems: The Case of the Kayapo Indians of the Brazilian Amazon." *Agroforestry System* 3:139-158.

Prance, G.T. (1980) "A Terminologia dos Tipos de Florestas Amazônicas Sujeitas a Inundações" ("The Nomenclature of Amazonian Forest Types Subject to Flooding"). *Acta Amazônica* 10:495-504.

RADAM [Radar da Amazônia] (1974) *Levantamento de Recursos Naturais* (*Natural Resources Survey*) Rio de Janeiro: Departamento Nacional de Pesquisas Minerais.

Roosevelt, A.C. (1989) "Resource Management in Amazonia Before the Conquest: Beyond Ethnographic Projection." Pp. 30-62 in D. Posey & W. Balee (eds.) *Resources Management in Amazonia: Indigenous and Folk Strategies.* New York: The New York Botanical Garden (*Advances in Economic Botany, Vol. 7*).

——— (1991) *Moundbuilders of the Amazon: The Geophysical Archeology on Marajó Island, Brazil.* New York: Academic Press.

Ross, E. (1978) "The Evolution of the Amazon Peasantry." *Journal of Latin American Studies* 10:193-218.

Shukla, J., C. Nobre, and P. Sellers (1990) "Amazon Deforestation and Climate Change." *Science* 247:1322-1325.

Siqueira, A.D., and R.S.S. Murrieta (n.d.) "Dietary Intake: A Parameter of Nutricional Status of Three Caboclo Populations of Marajó Island, Brazil." Paper presented at the 4th. World Academic Conference on Human Ecology, Mérida, Mexico, July, 1993.

Siqueira, A.D., E.S. Brondízio, R.S.S. Murrieta, H.P. Silva, W.A. Neves, and R.B. Vietler (1993) "Estratégias de Subsistência da População Ribeirinha do Igarapé do Paricatuba, Ilha de Marajó, Brasil" ("Subsistence Strategies of the Riverine Population of the Paricatuba River, Marajó Island, Brazil"). *Boletim do Museu Paraense Emilio Goeldi*, Série Antropologia 9:153-170.

Skole, D., and C.J. Tucker (1993) "Tropical Deforestation and Habitat Fragmentation in the Amazon: Satellite Data from 1978 to 1988." *Science* 260: 1905-1910.

Skole, D., W.H. Chomentowski, W.A. Salas, and A.D. Nobre (1994) "Physical and Human Dimensions of Deforestation in Amazonia." *Bioscience* 44:314-322.

Stocks, A. (1983) "Candoshi and Cocamilla Swiddens in Eastern Peru." *Human Ecology* 11:69-84.

Spruce, R. (1908) *Notes of a Botanist on the Amazon and Andes* (A.R.Wallace, ed.). London: Macmillan.

Stern, P.C., O. Young, and D. Druckman, eds. (1992) *Global Environmental Change: Understanding the Human Dimension.* Washington, DC: National Academic Press.

Strudwick, J., and G.L. Sobel (1988) "Uses of *Euterpe Oleracea* in the Amazon Estuary, Brazil." *Advances in Economic Botany* 6:225-253.

Turner, B.L., and S.B. Brush, eds. (1987) *Comparative Farming Systems.* New York: The Guilford Press.

Turner, B.L. and W.E. Doolittle (1978) "The Concept and Measure of Agricultural Intensity." *Professional Geographer* 30:297-301.

Turner, B.L., R.Q. Hanham, and A.V. Portararo (1977) "Population Pressure and Agricultural Intensity." *Annals of the Association of American Geographers* 67:384-396.

Vasey, D.E. (1979) "Population and Agricultural Intensity in the Humid Tropics." *Human Ecology* 7:269-283.

Wagley, C. (1953) *Amazon Town.* New York: Macmillan.

Wallace, A.R. (1853) *Palm Trees of the Amazon and Their Uses.* London: J. Van Voorst.

Weinstein, B. (1983) *The Amazon Rubber Boom, 1850-1920.* Stanford, CA: Stanford University Press.

Wilken, G.C. (1987) *Good Farmers. Traditional Agricultural Resource Management in Mexico and Central America.* Berkeley: University of California Press.