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A MODERN TRAGEDY OF THE NON-COMMONS:
AGRO-INDUSTRIAL CHANGE AND EQUITY IN BRAZIL'S BABASSU PALM ZONE

A Thesis

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by

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BIOGRAPHICAL SKETCH

Peter H. May was born in New York City in 1952. He was awarded the Bachelor of Arts degree by the The Evergreen State College in Olympia, Washington in 1974. Afterward, he spent a year as a development planner in Honduras, studying social and economic impacts of tourism. He initiated study toward the Masters in Regional Planning at Cornell University in 1975, interrupting this with a year of consulting practice as an environmental planner in Washington, D.C., and received the degree in January, 1979. His thesis treated institutional conflicts in rural water quality management in the United States.

Returning to Honduras in 1978, Mr. May was involved in a project for community-based processing of corozo palm fruit with the Black Carib society. The next year, he took an assignment as Extension Associate with the New York State Soil and Water Conservation Committee. In 1980, he began study toward the Ph.D. in Agricultural Economics at Cornell University. The initial encounter with palms in Honduras and concern with common property resource management guided his eventual dissertation research on babassu palms, a relative of corozo, in Brazil. In 1986, he and his wife, sociologist/ planner Linda M. Gondim, also a Cornell Ph.D., will be Visiting Professors at Brazil's Federal University of Ceara in Fortaleza.

A MODERN TRAGEDY OP THE NON-COMMONS:
AGRO-INDUSTRIAL CHANGE AND EQUITY IN BRAZIL'S BABASSU PALM ZONE

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Cornell University, 1986

Agrarian change and industrial innovation jointly affect the economic role of successional babassu palm forests that cover a large part of Maranhão, a state in Northeast Brazil. Over three hundred thousand landless peasant households derive nearly one-third of their cash incomes from the palm's oil-rich kernels, raw material for a regional vegetable oil industry; virtually all parts of the palm are useful to the subsistence economy for food, fuel, fiber, and shelter.

The inquiry concentrates on social equity effects of property rights alterations, studied during 15 months of field research in Maranhão. Land use (chiefly pasture) conversion and technical change in both agriculture and babassu industries have redefined property rights. Rural employment contraction is the primary impact. Initial rights over palms and land effect the ultimate distribution of rewards from innovation.

A tragedy of the non-commons arises where a powerless peasantry is unable to secure compensation for external costs caused by resource privatization. Delimitation of access to palms and land increases pressure on remaining resources traditionally managed in common, hastening their degradation.

The study compares babassu's importance to rural producers differentiated by enterprise scale and social organization between two agro-ecological subregions. Palm exploitation rates vary considerably between the areas studied. This suggests that industrial development prospects and associated employment impacts are geographically distinct. If agro-pastoral development is combined with industrial innovation in babassu fruit processing in areas where peasants already exploit most palms, employment will be severely curtailed. However, where babassu exploitation rates and agro-pastoral development potential are low, industrial innovation may generate new employment.

Technologies which supplant manual kernel extraction and subsistence uses with plantation agro-industry will invariably be accompanied by costly distributional consequences. To compensate those displaced means altering development policy to partition rewards so that peasant producers become beneficiaries rather than victims of technical progress. Policy and organizational strategies are suggested to ensure that benefits of industrial innovation are equitably distributed.

DEDICATION

I dedicate this modest contribution to the _quebradeiras_ of babassu and their families, who struggle against great odds to survive the changes in their conditions, and whose good humor and warm generosity to this wandering gringo will never be forgotten.

To my wife Linda who, in converting me forever to a hard-core Brazilianist, shared at least some of the joys and much of the agony of bringing this work to fruition. "_Amanhã hã de ser outro dia_."

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Behind any work of original research stands an original committee chairman. David Allee's well-grounded institutionalism guided the intellectual underpinnings of the thesis. His support, no matter where my spirit led me, kept me afloat well before he brought me into Agricultural Economics. Committee member Daniel Sisler must be attributed with the evolution of this dissertation, from its inception in the germ of an idea to a carefully argued and internally consistent treatise. Minor members Frederick Buttel and Ernest Hardy also made important contributions as the thesis evolved. Others at Cornell who were instrumental in advancing my intellectual development and whose financial support enabled me to complete two advanced degrees include Peter Jutro, Norman Uphoff, Porus Olpadwala, Edwin Oyer, and Larry Zuidema.

It can truthfully be said that the research embodied in this dissertation would never have been accomplished, nor would it have achieved its interdisciplinary strength were it not for the seminal ecological and anthropological fieldwork by Anthony and Suely Anderson. The Andersons took the time to explain their results and criticize my hypotheses. Anthony's introduction to Michael Balick and Ghillean Prance of the Institute of Economic Botany (IEB) at the New York Botanical Garden led to a lasting collaborative relationship and financial support for my fieldwork. This research gained amplitude through additional support from the Inter-American Foundation, National Science Foundation, Scott Paper Company Foundation, and Cornell University's Center for International Studies.

The IEB researchers are concerned that the socio-economic factors affecting the future of the babassu industry be incorporated with basic research underway on the palm's genetic variability and potential for domestication, with funding from the Science Advisor, U.S. Agency for International Development. On the advice of my sponsors at the IEB, my contribution to the collaborative Brazilian-U.S. project on babassu palm domestication was conducted under the institutional auspices of Brazil's Centro Nacional de Recursos Genéticos (CENARGEN), part of the Empresa Brasileira de Pesquisa Agropecuária, and the Instituto Estadual do Babaçu (INEB) of Maranhão. At CENARGEN, Lidio Coradin, Jairo Silva, and Dalmo Giacometti helped to both get me into Brazil, and keep me there for the duration of my fieldwork, while Eduardo Lleras of IICA provided stimulating debate. Appreciation is also due the Conselho Nacional de Pesquisa Cientifica for approval of my fieldwork in the babassu zone.

In Maranhão, I was welcomed as an active team member in the staff of the Agricultural Technology Division of INEB. José Mário Frazão, as the Division's Director, my colleague in field research, and close personal friend, guided me through the intricacies of maranhense society, trying (unsuccessfully) to protect me from my own ingenuousness. INEB's staff assured my peculiar needs were met. Special thanks are due to Pedro Buna and agronomists Claudio Pinheiro and Enilde Barbosa.

My compatriot Darrell Posey, a resident of São Luis and my favorite ethno-entomologist, was a frequent companion on beach and dining jaunts, and loaned me his precious jeep so I could visit my informants without fully sinking my fusca in the mud. Darrell's teaching attuned me to cultural nuances in people's cognition of their environment. I also appreciate the intellectual support and comeraderie of my colleagues in research on the babassu industrial economy — Wilson Milfont, Pedro Pick, Jair Amaral, Adir Juliano, and the Núcleo de Estudos Econômicos of the Fundação de Tecnologia Industrial. Akira Kono and Mariano Mendes shared their keen insights on the peasant economy and potential of whole fruit processing.

Warwick Kerr, Head of the Biology Department of the Federal University of Maranhão, graciously invited me to present my findings to the department seminar. The Maranhão Association for Defense of Human Rights provided the opportunity for a fruitful debate with my fellow social scientists concerned with equity issues of development in the babassu zone during a talk on my research.

Throughout the fieldwork itself, I was fortunate to have in my service Inácio dos Santos and Aurélio Carvalho, skilled enumerators who accompanied the survey households during the entire crop cycle of 1983-84, despite torrential rains, venemous snakes, stubborn bicycles, and other mishaps. Others who assisted in enumeration and data compilation at various stages in the fieldwork include Odair, Vicente, Mariano, Wilson, Enilde, and Zaira.

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BABASSU: SUBSIDY FROM NATURE AND PROBLEM RESOURCE

Economic development in tropical regions has increasingly been linked with awareness that careful management is necessary for sustained utilization of natural resources (NRC, 1982). The roles of native plants as resources in agricultural systems have recently emerged as a focus of research and development. Where native plant resources and the benefits derived from them by rural populations are threatened due to over-exploitation or deforestation, efforts are being made to protect the genetic pool and improve plant productivity as crops (NAS, 1975). Elsewhere, the same species may be perceived as new resources that have potential for incorporation into farming systems (Blair et al., 1983).

This study examines the effects of agrarian change and industrial innovation on the historical role and resource potential of forests of babassu palms (Orbignya spp) in an economy of shifting cultivators who are primarily landless peasants and cattle ranching landowners in the Brazilian state of Maranhao. The babassu zone is one of transition between humid forests of the Amazon basin and semi-arid lands of Northeast Brazil. Babassu palms, initially only one of many components in the original species-rich forests that covered the region, have emerged in succession as the dominant tree species after settlers cleared the original forests at the frontier for crops and pastures.

The Subsidy

Like other successional forest species, babassu palms provide a "subsidy from nature" to agricultural systems. This subsidy takes the form of both a nutrient input to soil fertility and a source of market and subsistence products. Shifting cultivation, still the dominant agricultural technology in many areas of the tropics, relies upon ash derived from burning of forest trees and underbrush for nutrients. Tropical forests hold the principal mineral elements needed for plant growth locked-up chiefly within woody tissues. Shifting cultivators must have access to large areas left as fallow to restore nutrients through the vegetation. Only after a sufficiently long fallow will crop productivity compensate the effort required to clear land anew each year. In many regions of the tropics, fallow periods have been shortened or eliminated as a result of population pressure or tenure constraints, causing a decline in agricultural productivity and degradation of forest resources (Sanchez, 1976; Kunstadter, 1978; Siebert & Belsky, 1985).

In contrast, where babassu is the dominant fallow species, shifting cultivators are able to sustain production under relatively short cycles, even if soils are low in fertility. A high rate of biomass production in babassu, most in the form of palm leaves, enables shifting cultivators to return to the same site within four or five years after clearing (Anderson, 1983). Instead of clearcutting, the farmers need merely thin the babassu stands. They then burn the leaves and unproductive palms found on the site. This provides nutrients sufficient for producing rice, maize, beans and cassava under the palms that remain. Most farmers in the babassu zone plant these crops without recourse to either mechanical implements or chemical fertilizers. Yet, they produce enough to supply the urban population of the region as well as other Northeast Brazilian cities with rice and products derived from babassu.

Since they need to cut only leaves and a small proportion of palms, farmers are able to retain mature productive palms within the crop field. These will provide valuable subsistence products and a cash supplement to small farmers during the fallow. Babassu palms generate a host of useful products from their fruit, leaves, and stems. Of chief economic importance among these products are the oil rich kernels derived from the fruit, an extremely hard multilayered nut.

Despite efforts over the years to industrialize babassu kernel extraction, the vast majority of kernels produced are manually extracted by women and children by hitting the fruit with a club against the upturned blade of an axe. The kernels, used in a major regional oil industry, are sold to landowners and merchants, furnishing an important source of cash or in-kind income for small farm households. This income is particularly important because it arrives during the period between annual crop harvests, supplying the resources needed to obtain food and other goods essential to peasant households' survival, particularly during times when annual crop harvests are poor.

Babassu husks, converted to charcoal by the same families, constitute the single most important source of fuel used for cooking and food processing. Additionally, babassu leaves provide fiber for basketry, thatch, and fencing; the stem produces palm heart, which, together with fruit residues and young leaves, is used as feed for livestock. These latter forms of the subsidy from nature become crucial where peasant access to other resources is restricted, poor terms of trade exist for agricultural products, and where low wage levels and limited employment opportunities prevail. Were it not for babassu, landless families would be more vulnerable to crop loss and other sources of deprivation which make their ability to remain in regional agriculture increasingly difficult.

Besides their importance to peasant households, babassu palms furnish raw materials for an important regional vegetable oil and feedcake industry. This industry is composed of some 50 factories of varying scale and technology within and near the babassu zone. For many years one of the region's principal sources of income, babassu kernel still constitutes the principal source of lauric type oils used for making soaps and cosmetics in Brazil. This industry has been cited as the largest in the world wholly based on an oilseed extracted from a native (wild indigenous) plant species (Markley, 1971); in 1979, babassu kernel oil and feedcake worth approximately US$ 135 million were produced for domestic and international markets.[1] Expansion in the industry over the years has meant a growth in markets for the kernels peasants extract, and has reinforced the linkage between peasant agriculture and the palm forests. This market has also served as an incentive for landowners to retain the palms and the peasantry within their properties, nourishing what have been mutually beneficial production relations, despite their paternalism.

The Problem

In certain areas, babassu palms have become a resource problem. This has occurred where the successional forest of native palms on which many rely is being rapidly eradicated and where new landowners restrict production by peasants within the palm stands that remain. Since those who depend most on babassu are primarily landless peasants, eradication of the palm or curtailment in fruit collection rights will erode peasant welfare and restrict their ability to continue as agriculturalists in the babassu zone.

The native palm forests and landless peasantry on which the babassu oil industry ultimately depend are threatened by changing land use. Deforestation forces merchants to purchase raw materials from more distant producers. Decisions by some landowners to move toward ranching and mechanized agriculture

[1] This estimate is in current 1979 prices, based on Gessey-Lever figures (n.d.) for oil production, and a 35 percent conversion rate for feedcake equivalent. Oil prices are those in domestic markets; feedcake price is FOB São Luis, Maranhão for export markets. Prices obtained from the Bank of Brazil's Export Finance Commission (CACEX).

reduce the land available for shifting cultivation, which complements babassu gathering and kernel extraction as the peasants' principal sources of livelihood. Because the oil industry is for the most part not vertically integrated with kernel production, raw material supply may be threatened by changes in rural conditions beyond the industry's control. These changes have implications beyond the survival of the peasantry themselves. The food crops produced by those displaced from regional agriculture are being supplanted by products destined for markets external to the region.

Paradoxically, one of the solutions proposed as a means for preserving the palm forests may further undermine the peasants' welfare position. Innovative processing technology for whole babassu fruit has been introduced in the region. This technology offers the potential for industrial utilization of a number of by-products such as charcoal, tar and starch that could add needed dynamism to an industry that has lost momentum due to problems of idle capacity and competition in final product markets. Proponents of the new technology feel the prospect for marketing entire fruit instead of only the oil kernel will induce landowners to retain native stands of babassu palms and improve their productivity. While the economic rationale for stand retention may improve with new markets, mechanical processing of whole babassu fruit will probably employ drastically fewer people than those active in the current cottage industry (Mattar, 1979), and may also reduce palm products available for subsistence. Whole fruit marketing has brought about lasting changes in the terms under which peasants obtain access to babassu stands for collection, and the relative shares of the proceeds from product marketing which accrue to them. The shift toward whole fruit marketing appears complementary with the move toward temporary wage labor hired for restricted seasonal activities, reinforcing the process of peasant exclusion from property rights to land and palms which they have enjoyed in the past.

Objectives and Organization

The principal objective of this study is to examine how changes in property rights (access to palms and land) and technical innovation in the processing industry may affect the welfare position of the peasantry of the babassu zone. The set of circumstances surrounding dispossession of peasants' property rights, where the gainers are under no pressure to compensate the losers, I define as a "tragedy of the non-commons." The sources and dimensions of a non-commons tragedy are explored in Chapter II. At the same time, I introduce successional palm forests as resources whose use rights are being curtailed in the babassu zone. The geography and history of the study area are presented in Chapter III along with a description of research methods employed during 15 months of fieldwork in Brazil.

Next, I assess the positive and negative features of traditional babassu agricultural systems, focusing on the relationships between landowners and peasants in the definition of property rights over land and palms. A typology differentiating rural enterprises as they appear in the region today is set forth in Chapter IV. In the remainder of Chapter IV as well as throughout the following chapters in Part I, my aim is to compare the economic importance of babassu to these different types of producers, along the lines of tenure, scale and enterprise organization. A second objective is to describe the processes of change underway in farming areas of the babassu zone. This reveals some of the factors that appear to be affecting the pace and direction of that change.

In the second part of Chapter IV, changes over the past 20 years in farm management among properties in the Itapecuru Valley in eastern Maranhão are examined. Chapter V assesses the benefits obtained from babassu as a component of peasant production systems in two contrasting subregions of the babassu zone. Together with historical data and information on current conditions obtained from farmers and other informants, Chapter VI offers a perspective on what makes retention of the palms a preferred option for some landowners, and the rationale for the growing trend toward palm eradication. This serves as the basis for estimating the amount of land from which babassu may have been removed. Assuming the changes affecting regional agriculture will continue, I predict the effect on peasant employment and access to resources.

In Part II of the thesis, I consider how the babassu industry's organization and technology affect the survival of the babassu forest and the peasantry. This involves an analysis of the market prospects that will make babassu a valuable or a marginal asset to landowners. In Chapter VII, I examine the role of the traditional babassu kernel oil industry — especially its final product markets, internal organization, and relationship to its raw material sources. I subject price formation and margins at different levels in the kernel marketing chain to time-series analysis. Finally, the conditions in the babassu industry and product market conditions are related back to the historical and current situation at the farm level to draw links between industrial conditions and landowner behavior.

The next step is to consider how technical innovation in babassu processing may influence the landowner's decisions affecting palm forests and the peasantry. I present the parameters of a whole fruit processing industry in Chapter VIII, with reference to the pilot operations already initiated and previous technical and economic assessments of this innovative process. This makes it possible for me to infer how such an industry might fare under current Brazilian economic circumstances. The landowners' differing perspectives on the aims of their enterprises affect their relative susceptibility to alter production arrangements in accommodating the new industry's raw material requirements.

Finally, I consider the implications for the peasantry of a dramatic shift toward whole fruit processing. The analysis is by necessity deductive, as industrial innovation is as yet in its infancy. Survey results by my colleagues in babassu research suggest the types of social impacts that may be expected. These impacts will vary in accordance with the relative bargaining positions of those affected by the change. I then assess the magnitude of employment displacement and subsistence benefits foregone due to a shift toward a centralized whole fruit processing industry, given the current distribution of resources. The labor surplus in the regional and national economy suggests that labor freed from rural production will not be more efficiently employed elsewhere.

Chapter IX explores several technical alternatives affecting development processes underway in the babassu zone, after providing a synthesis of the preceding discussion. The options considered include establishment of plantations of genetically improved babassu palms, and development of farm level babassu fruit processing technology. In the final chapter of the thesis, I formulate a set of specific policies that might be considered as means to ensure that the rewards from agro-industrial change in the babassu zone are equitably distributed. Instruments for institutional reform in property rights, credit availability, and marketing mechanisms, as well as avenues for further research are presented.

CHAPTER II

PROPERTY RIGHTS AND THE TRAGEDY OP THE NON-COMMONS

This chapter provides a theoretical basis for evaluating social equity effects of property rights changes resulting from land use conversion and technological innovation. The key concern is to assess the contribution of property rights theory to identifying how the benefits from resource investment ought to be partitioned. The Brazilian babassu case examined in detail below is appropriate for exploring this issue because investments in pasture establishment and industrial technology innovation will probably reduce current land resource users' access to the multiple benefits they have traditionally enjoyed from the palm. The initial rights over palms and land contribute to the ultimate distribution of rewards from innovation.

The economics literature on agrarian transformation largely suggests that technical innovation in response to changing factor or market prices or in their proportions will lead to a more efficient agriculture: more food, fiber, and fuel produced by less human toil and at a lower cost to consumers (Hayami and Ruttan, 1971; Schultz, 1964). Those displaced from less efficient forms of production will be absorbed by other sectors, whose growth is stimulated by the added surplus derived from a more efficient agriculture.

The form of agricultural development policy adopted may affect the degree to which efficiency is achieved. For example, factors such as the size of land unit and type of technology targeted for subsidized capital investment may affect the pace at which agrarian transformation occurs, and its ultimate efficiency in use of resources when compared with actual factor proportions. The aim of rural development has principally been to alter existing agricultural systems via technological change and to facilitate reorganization of the production process through infrastructure improvements. The environmental and social costs of moving to a more "efficient" state may also exceed the benefits derived from the change. Norgaard (1983) described as "coevolutionary" development processes that are sensitive to the physical capacity of local environments and meshed with the innovative potential of local inhabitants to transform that environment for their needs.

A focus on the efficiency or even coevolutionary potential of a given development path is not sufficient in an analysis of changes in the control over resources (Dasgupta, 1982). Rapid capitalist development has displaced a powerless peasantry at a rate inconsistent with the capacity of the nonagricultural sectors to absorb them. Unless we are to rely upon some notion that the weak deserve to be disinherited as an outcome of the division of common resources (as Hardin, 1968, and other social Darwinists suggest) the question of fairness must be brought to the forefront in an objective assessment of the returns from innovation. The issue of rural resource development becomes not just "how much?" but also "for whom?"

This chapter begins by considering the economic potential of agricultural systems containing successional palm forests as resources and the reasons that such systems have tended to be ignored in development. It then reviews previous efforts to examine extractive economies from a neoclassical perspective, and some of the shortfalls in analysis based on assumptions of a perfect market. A discussion of the evolution of property rights theory then lays the groundwork for institutional criteria useful for examining change in agro-industries based on the babassu palm.

Successional Palm Forests as Resources

Secondary forests have grown considerably in global importance as the population of shifting cultivators has expanded throughout the lowland tropics. According to estimates by Wadsworth (1983), secondary forests cover nearly 900 million hectares of the world, of which about 40 percent lie in tropical America alone. Shifting cultivation is not the only process by which primary forests are converted to secondary growth. Roughly half the area converted from forest to pasture over the past decades in the Amazon region has returned to secondary forest due to pasture mismanagement and degradation (Tardin, 1979; Hecht, 1982).

Shifting cultivation and extractive activities in secondary forests are commonly regarded as destructive, predatory land uses that should be replaced with intensive continuous cultivation methods. Forest fallows have often been viewed as unused, unowned, abandoned land. It is convenient for politicians and investors to argue that fallows are essentially "unoccupied" because such lands are much easier to appropriate or transform than if they are perceived to be under efficient management (Dove, 1983; Massing, 1979; Tendler, 1980). In fact, secondary forests are anything but "abandoned." Fallow sites constitute an important source of household subsistence and often a cash income supplement. A description of the links between successional forests of babassu palms and small farm production in the study area in Maranhão offers one example of how these systems are intertwined.

Babassu Agroforestry Systems

Palms and regional cropping systems are closely linked in the babassu zone in what may be described as "agroforestry" practices. The term agroforestry refers to the integration of annual crops or animals and woody perennials in time or space (Editors of Agroforestry Systems, 1983). In the case of babassu, both annual crops and animals are managed under self-propagating palm stands.

For the most part, the producers in babassu-associated cropping systems are not those who control the land. While use rights over palms are linked with access to land, people share common rights of usufruct over palm stands under traditional property arrangements. In the framework of this study, then, land may be considered a resource vulnerable to a "non-commons" preemption in use rights, while palms are traditionally managed as common resources, subject to access to the land. Shifting cultivators prefer to plant crops on sites where babassu is plentiful. This is true because the presence of babassu signals soil/moisture relations propitious to crop growth (Moran, 1981), and because, under some property systems, the farmer who produces annual crops on a given site perceives the right to harvest second growth and palm products which emerge during the fallow.[1]

After secondary forests recover in sites used for shifting cultivation, farmers harvest useful tree species as polewood or timber during land preparation for cultivation. The age of the second growth that is to be slashed for shifting cultivation is a major determinant of crop productivity, since the principal source of plant nutrients are those derived from burning.

As an element of the cropping system, babassu functions primarily as generator of biomass for the intense burn of secondary forest growth necessary to provide nutrients, reduce weed infestation and open terrain for cultivation. Babassu is cited as being among the most efficient biomass producers among forest species in tropical dry-moist biomes (Anderson,

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[1] The right to fallow resources has been documented in many shifting cultivation systems of the world (see Dove, 1983; Belsky, 1985). Property rights over the successional regrowth on babassu sites used for shifting cultivation have been documented by Soares (1981) for the case of communal lands in Bom Jesus in Lima Campos, Maranhão. Usufruct to privately owned extractive resources in the babassu zone is generally provided to those who have made an agreement with the landowner to live and plant crops on the property. Such rights are currently threatened, as will be described in greater detail in Chapter VI.

1983). In a dense babassu stand in central Maranhão, Anderson (1985) reports that the leaf biomass totalled 69.1 metric tons[2] dry weight (DW) per hectare[3] and an annual leaf production of 16.8 m.t. DW was recorded. Both the biomass level and production rate are considerably greater than those of other seasonally moist tropical forests having different species composition, which rarely exceed 10 m.t. of biomass held in living leaves (Anderson & May, 1985). Babassu is similar in this sense to African oil palm, whose above-ground annual dry matter production in intensive cultivated plantations in Malaysia is 31.3 tons per ha. (Ng, 1968). A burned stand of babassu requires about four years to recover its full leaf biomass.

High leaf productivity in babassu enables farmers to obtain sufficient fuel for shifting cultivation by cutting leaves instead of stems. Cutting leaves reduces shading of cultivated crops during the subsequent growing season. Moderate thinning of mature babassu palms assures that a variety of subsistence and market products will be available during the fallow.

Research on babassu stands, as well as native African oil palm managed at different densities, suggests that thinning and undergrowth management improve individual palm productivity considerably. Periodic burning and removal of unproductive

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[2] One metric ton (ton) = 1,000 kilograms (kg.) or 2,200 pounds. Unless otherwise indicated, the metric system is used throughout this dissertation.

[3] One hectare (ha.) = 10,000 square meters or 2.47 acres.

and senescent babassu palms appears to have the effect of increasing overall fruit production per unit of land (Kono, 1976; Mendes & Carioca, 1981; Zeven, 1967).

In babassu-associated cropping systems, farmers thin stands of senescent and unproductive palms to between 50 and 100 adult palms per ha. Farmers use leaves cut from the remaining palms to provide fuel for the burn (Figure 2.1), as well as to meet storage and shelter needs; baskets of various shapes and sizes are fashioned of the palm fronds, as is roof thatch, fencing and twine.

After the annual burn, mature palms quickly regain fruit productivity, and recover completely after between two and three years, according to local farmers. This occurs because heavy leaf sheaths protect inflorescences (some of which yield fruit once the pistillate flowers are pollinated) from the destructive effects of fire.

The link between babassu and annual crop production is most clearly apparent in the division of labor throughout the annual crop calendar.[4] From August to November, men are generally active in land preparation (clearing, burning, fencing). Babassu fruits have their peak maturation during this same period. Women and children, whose labor is not critical for the land preparation phase, are hence occupied in collecting and breaking babassu fruit to extract the valuable

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[4] Data describing the crop calendar is based on small farm interviews conducted for this study. A more detailed analysis of labor allocation patterns is presented in Chapter V.

Figure 2.1. Babassu leaves spread in roça in preparation for burning.

oil kernel, which they sell immediately to purchase foods and other goods. Despite the preeminence of female and child labor in babassu fruit breaking, men are active during the pre-planting season (November-December) in fruit collection; this and other babassu-related activities such as charcoal production and leaf harvesting require more of their time than agricultural activities. As rains appear in late December to January, more family members become active in planting and, in February, weeding crops, while babassu collection and breaking become less important. People continue gathering babassu fruit from the ground during the rest of the crop cycle as a secondary activity, limited by labor requirements in weeding and harvesting annual crops, as well as reduced fruit production within the stands.

In the slack period between weeding and harvesting, babassu kernel extraction again takes on a greater relative importance in labor allocation. The harvest period from May to June involves most household members in rice cutting, either on their own shifting cultivation plot, or as wage laborers on the lands of others. Babassu fruits by this point are far more difficult to find, and many have either germinated or deteriorated due to seed predation or waterlogging. However, by the time crops are in, the preparation of the next year's shifting cultivation site coincides with the initiation of a new babassu fruit harvesting cycle.

The balance of labor allocation between babassu extractive activities and agricultural production means that poor rural households can make use of available labor in more diverse ways throughout the year. All household members are thus enabled to contribute directly to cash income and subsistence goods production, both essential for maintenance of welfare.

Physical Characteristics of Successional Forests

Successional ecosystems and the species within them which are important to local economies have not been well understood by development practitioners. One reason for this is the emphasis in technical training and research on single-species annual or perennial systems of production. The diversity present in secondary forests, even though considerably lower than that found in primary tropical forests, is an obvious obstacle to incorporating successional management in development strategies. Species that emerge in succession are typically treated as weeds. Their competition with annual or perennial crops is costly to combat, demanding substantial labor or application of herbicides, which represent costs that can undermine the productive potential of improved agricultural technologies.

The alternative to elimination of invading successional species is to manage the secondary forest regrowth in such a way as to "mimic" the successional process, while incorporating useful species as plantings within the fallow. Some simplified sequential cropping systems attempt to emulate the successional process by providing greater ground cover and transforming crop fields from herbs to shrubs and finally to forest trees (Heveldoop & Lageman, 1981). Such methods have been evolved over millennia by indigenous societies, and many peasant groups throughout the tropical Americas are familiar with some aspects of successional management (Altieri, 1983; Gliessman et al., 1980; Posey et al., 1984). The problems in attempting to adapt indigenous methods for managing fallows for the purpose of technology standardization and transfer are that such methods are often site-specific, and their knowledge is retained only by a few specialists whose cultures are dying.

Although the diversity of tropical forest fallows is a stumbling block preventing adaptation of management technology, many successional forests, particularly those dominated by palms, have relatively low diversity. Such forests present positive environmental characteristics, while their lower diversity reduces the complexity of management. They are simple, fairly stable (unless subjected to severe land use pressure), easy to manage, and require few inputs.

Besides the economic benefits generated by secondary successional forests, another factor that is often overlooked is their ability to aid in site recuperation by accumulating nutrients, improving the physical properties of soils, and maintaining hydrologic regimes. The total stock of nutrients biologically immobilized in vegetation increases with succession, and is principally held in wood biomass (Snedaker, 1980). Recycling of nutrients immobilized within the secondary regrowth generally requires that shifting cultivators cut the forest and burn the biomass. Despite the rapid rates of biomass decomposition common in the tropics, a strategy of production reliant on release of nutrients from rotting of woody tissues is insufficient to ensure timely fertility improvement in slashed sites. Fire is also necessary to suppress weed and pest infestation.

The length of fallow cycles is determined by the rapidity with which the secondary succession is able to immobilize soil nutrients. Among successional systems, palm forests are important in this regard because, as described in the previous section, they allocate a far greater proportion of their resources to leaf and inflorescence production rather than to wood (Anderson, 1983). This enables shifting cultivators to cut leaves rather than stems, thus ensuring more rapid rejuvenation of fallow and economically useful products.

Soil bulk density and water infiltration rates have been shown to improve as succession proceeds (Bartholomew, 1953; Ewel, 1980; Nye and Greenland, 1960; Zinke et al., 1979). This improvement in soil physical properties insures adequate root penetration and plant growth for successional species (thus speeding up site recovery) as well as for the crops planted at the end of the fallow cycle. The retention of ground cover is an essential factor in the management of watersheds, particularly over fragile and nutrient-poor soils of the humid and seasonally moist tropics. Upland forest cover on hill lands serves to protect and sustain not only the upland soil from erosion and leaching losses, but also to guard against uneven water flows and sediment loading in streams that would be detrimental to downstream water uses such as irrigated farming and hydroelectric energy generation (Hamilton, 1983).

Self-sufficient or Semi-Proletariat?

The view that shifting cultivation, through its gradual encroachment into fragile ecosystems, is at the root of the global problem of tropical deforestation (Myers, 1979) is at best a partial explanation. As we have seen, successional forests provide distinct benefits to agricultural systems. Placing blame for the malaise on overstocked common resources caused by burgeoning human populations (Hardin, 1968) is also insufficient. In Amazonia, which includes a fair share of the babassu zone, there is no real population pressure on scarce land resources. The problem is that the resources at the disposal of the vast majority tend to be restricted due to a highly skewed distribution of access to property rights (Hecht, 1985). Constraints on resource access, in combination with other factors, make agricultural production alone a tenuous strategy for most peasants.

In many developing countries, the agricultural sector has been subject to an implicit taxation through policies designed to fuel urban industrial growth. Price ceilings and, to some extent, food aid and other cheap food imports have undermined the net returns to agriculture for wage food production in many Latin American countries (de Janvry, 1982). In Brazil, this implicit taxation has been counteracted by subsidized input credits. During the 1970s, agricultural loans outstanding actually rose to levels <u>above</u> the gross value of annual agricultural product (Sayad, 1984). However, these low or negative interest credits have been limited in their availability to an extremely restricted group of investors at the very apex of the social pyramid. Graham et al. (forthcoming) estimate that over half the agricultural loans were extended to less than five percent of producers.

Agricultural credit has also tended to favor the already highly capitalized, export-oriented or import-substituting industrial raw materials processing sector, rather than the producers of wage foods (Goodman, 1984; World Bank, 1983a). Since most essential food products are produced by peasant households on small holdings or rented land (Graziano da Silva, 1982), cheap food policies frustrate the efforts of many such producers to meet cash needs through marketing of surplus alone. Studies have increasingly found that it is only the better-off farmers who obtain the majority of their incomes from their own agricultural production (Deere, 1981; Moran, 1982).[5] Even those who have secured permanent access to land in colonization areas are often unable to meet their needs solely through agriculture, because higher value

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[5] This finding was confirmed by surveys reported in Chapter V, below.

perennial or annual crops are difficult and costly to market from remote areas.

The two major additional sources of cash income are wage labor and extractive activity. Off-farm wages have increasingly become recognized as crucial to peasant survival (Deere and Wasserstrom, 1982; Swinton, 1983), as has the necessity for female participation in economic activities (Beneria, 1984; Bourke and Warren, 1979; Deere, 1982). Women's role is particularly important in small-scale extraction.

The contribution to rural welfare of extraction from renewable secondary forest resources, generating products having only minimal participation in formal economic market circuits, has remained obscure to development planners. Many extractive products constitute one of the few sources of income for rural women as well as a means for making productive use of female and child labor. Agricultural development practitioners tend to view agriculturalists principally as men, and their families as dependents. The obscurity of both successional species as resources and of the principal source of labor used in their extraction makes the potential of these resources even less obvious for development.

Extractivism, Exploitation, and Innovation

In addition to other factors which have made successional resources a less-than-obvious contributor to rural welfare, extractive activities are associated with an historical blight of severe human exploitation. The social relations through which extractive products are gathered and make their way into markets have tended to be ones of debt servitude or intermediary manipulation. In many cases, gathering and rudimentary processing are done by people possessing control over neither the resource nor the placement of goods in the market. These people therefore have little bargaining power to affect the share of the product's value that accrues to them; are often forced to live under terms of dependency to landowners, concessionaires or merchants; and are the first to suffer from the periodic booms and busts endemic to extractive industries. Where demand is intense and the physical resource base is accessible as well as limited, extraction may result in rapid degradation of the plant resource. By limiting supply, degradation will further push prices upward, and thus increase pressure on the resource. Extinction is a frequent result.

A process of market evolution leading to degradation of extractive resources has been proposed by Homma (1981) and by Repetto and Holmes (1983) for the case of subsistence resources in general. A description of this process following the tenets of static equilibrium analysis is presented in Figure 2.2, an adaptation of Homma's (1981) theory. Initially, demand (D_o) for the extractive product is presumed to be dormant, while supply (S_o) is high, since the resource is conceived as an open access "commons": anyone can obtain access to the resource to extract the product. Although an open access condition is posited to exist, the costs of extraction and marketing are severe due to absence of infrastructure or marketing channels. Hence, the supply curve hugs the Y-axis up to some point at which the minimum entry-level marginal costs would be redeemed by the market price.[6] Since neither producers nor consumers are satisfied with the price conditions available in this first stage, there is no extraction; the resource remains untouched.

In the second stage, infrastructure development in the area of an extractive resource enhances the product's marketability and reduces its extraction cost. Supply (S1) is able to satisfy the initial meager demand (Q1). However, the resource is underexploited at this demand level.[7]

With a successful marketing campaign, expansive domestic and international markets shift the demand curve to the right. Here, however, it hits up against a supply limitation. Due to the resource's fixed and limited character, sustainable supply at some point (in this case Q_2), becomes perfectly inelastic to price. An ecological equilibrium is

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[6] On this aspect, the model presented here differs from that of Homma, in which the supply curve begins at a point well out along the X-axis.

[7] Note that the order of events could well be reversed, which is often the case, as described below for the case of rubber tapping in the Amazon. Demand most frequently leads supply in stimulating entrepreneurs to develop the market infrastructure necessary to initiate trade in the extractive product. The reverse chain of events is presented here mainly for didactic purposes.

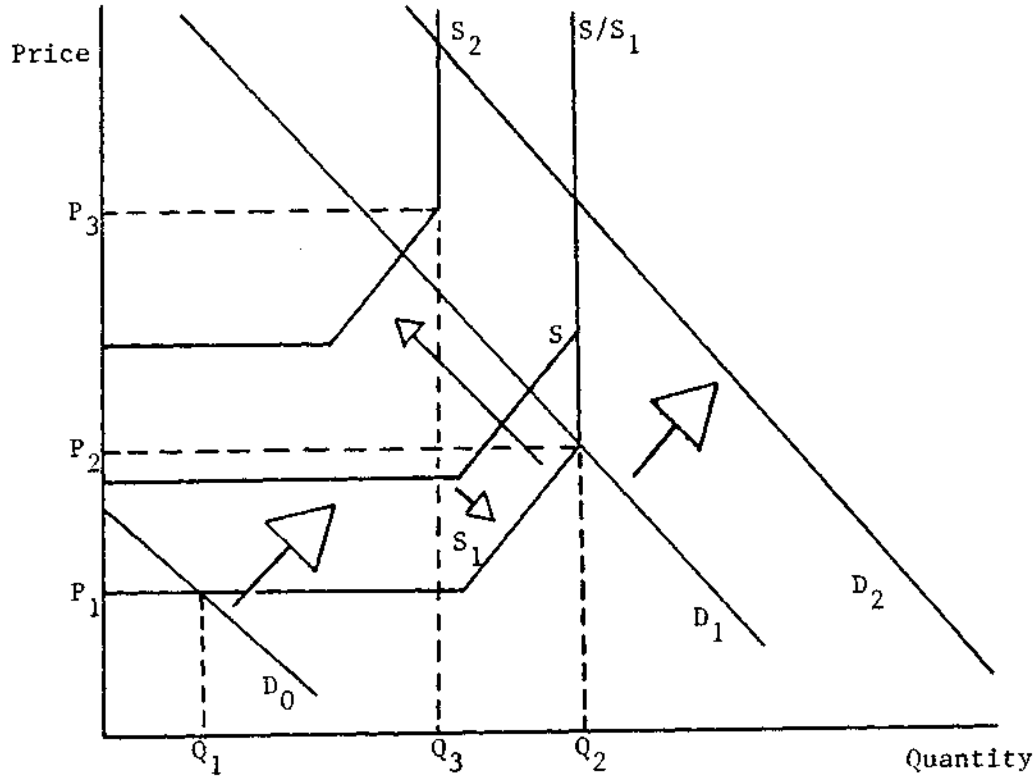

Figure 2.2. Model of the extractive product market (adapted from Homma, 1981).

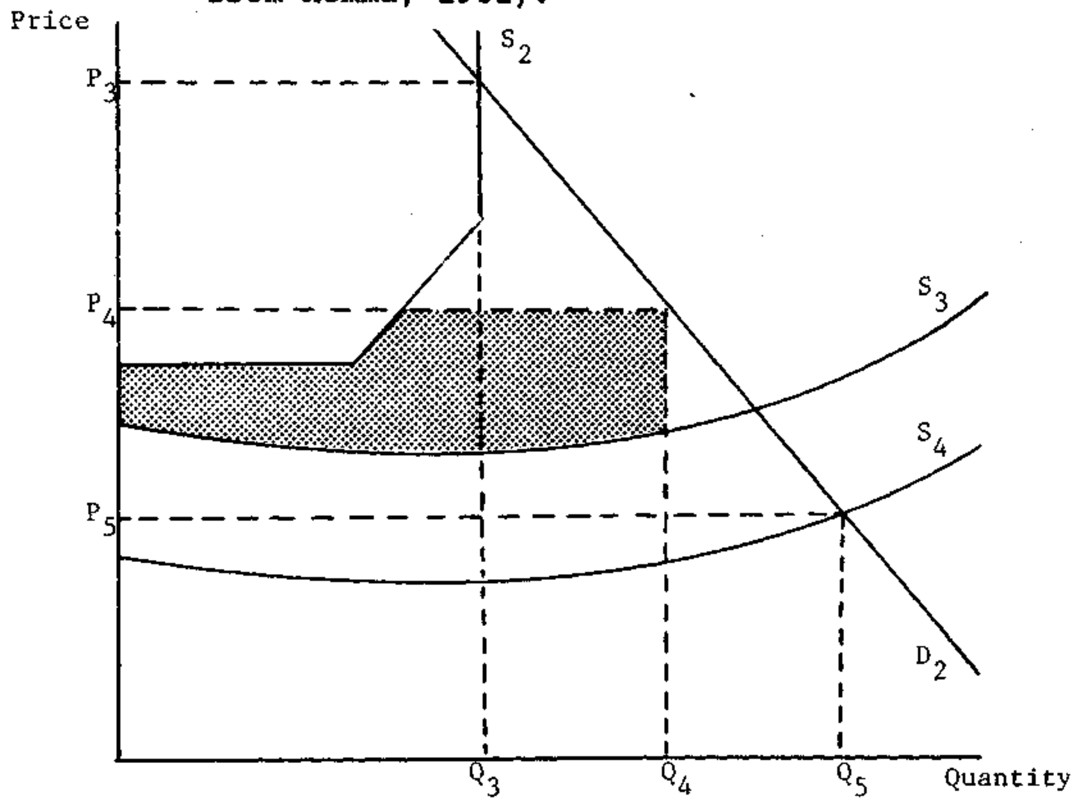

Figure 2.3. Innovation rents from rationalization of extractive industry following resource degradation.

attained at the point where Q_2 is harvested; at demand levels beyond this point (D_2), high prices will induce producers to overexploit the resource, eventually causing its diminished productivity if not total extinction. The supply curve shifts back and upward to S_2, but, because demand is unsatiated, pressure on the resource continues. Such pressures, under open access conditions, lead to the traditional "tragedy of the commons" (Hardin (1968).

Institutional options to restrain the rate of exploitation of the extractive resource may be pursued at this point. The specific direction taken by decision-makers (whether representatives of a central state or tribal leaders) to alter property institutions will determine not only the sustainability of the resource, but also the partitioning of benefits from its exploitation. Some societies have been able to define property rights so as to ensure broad enjoyment of surplus, while others have found it convenient to parcel out the rewards of resource control to a circumscribed elite. The extent to which rights to productive resources are concentrated affects not only the distribution of rents from resource exploitation, but also the size of the consumers' surplus enjoyed by the broader society.

In the case of babassu, peasants' initial rights of usufruct to palms are being curtailed, while their access to land for shifting cultivation is reduced with conversion to pastures. The peasants' share in the producers' surplus (the area between curve S_2 and price P_2 in Figure 2.2, less the share paid as rent to landowners) is thus restricted. If cattle output per unit of land is lower than the combined value of babassu kernel and cattle, and ranchers retain a greater proportion of their output as surplus, this conversion would result in a net decline in social welfare.

If land is plentiful enough, however, the peasant family will presumably be able to relocate to a different area where babassu is still abundant and cattle less so, resulting in no net loss from the conversion to pasture on the initial property. What happens, however, when the frontier is reached, is that the peasant family is forced onto land having lesser productivity or area for shifting cultivation, placing greater pressure on resources that remain. Similar to the pressures brought about through market forces, subsistence needs will increasingly result in resource degradation. Babassu supply will thus be forced upward and to the left, as in S_2 in Figure 2.2., and the size of the surplus accruing to peasants and consumers declines.

At this point, given technical feasibility, one of two things might occur to relieve pressure on the resource. One option is for discovery of synthetic substitutes for the natural resource product. Another is for genetic enhancement of the native species and its development under rationalized plantation conditions as a crop. In either case, the initial investment to make the necessary transition is fueled by the potential for innovation rents derived from the high prices caused by unsatisfied consumer demand in the last stage. In

Figure 2.3, these rents are equivalent to the area between S_2 and the supply curve for the synthetic industry or plantation system (S3). If the innovative industry satisfies just enough demand to bring the extractive industry back exactly to its sustainable level, it retains this market advantage. Since, at its initial stage, agro-industrial innovation is likely to be limited to one or a few firms, moreover, the amount supplied (Q_4) will be limited to that necessary to derive monopoly profits. As more firms enter the field, however, marginal production costs for the sector as a whole will become homogeneous (S4), and an equilibrium price and quantity will be attained (P_5 and Q_5).

Where extractive products are recognized as perennial crops suitable for expanded production in plantations, however, rationalization of production methods undercuts employment and wages in extraction. By reducing the costs of production, the rationalized system eventually eliminates the extractive system or reduces its share to an insignificant segment of the overall market. Since prices have been reduced over time by rationalization, extractive industries often require price floors or subsidies on production costs to maintain competitiveness. Those who control extractive resources are able to bargain for such policies because they typically constitute cohesive elites able to manipulate political action on their behalf.

As with land use conversion, the benefits of agro-industrial innovation are partitioned in accordance with the claims over resources. The innovation rents obtained in the first phase of process innovation or crop improvement are benefits which will nurture the infant industry while enabling it to undercut the extractive system. Those who control proprietary rights to the innovative process are made better off at the expense of original producers. Since the marginal costs of production are reduced, allowing a more full satisfaction of demand, and a threatened resource is protected from degradation pressures, society as a whole is better off. Yet, unless some claim is placed on innovation rents to compensate those displaced, the distributional consequences of the shift are not favorable.

The classic case of forest product extractivism in Brazil is that of rubber tapping in the Amazon (Santos, 1980). Usufruct to land containing rubber trees (<u>Hevea brasiliensis</u>) was conceded to entrepreneurs who imported workers from the dry Northeast. These workers were allotted tracts of land along navigable streams, where they made periodic rounds of sparse native trees (often averaging fewer than one rubber tree per ha.), which they tapped for the valuable latex. Once gathered in liquid form, the latex was smoked and solidified in large balls. The concessionaires plied their territories in river boats, trading commodities needed by the tappers for rubber and other extractive products. By extending credit for commodities at high interest and taking advantage of the virtual monopsony entailed by their control of the rubber stands, concessionaires kept their rubber tappers in virtual debt slavery. Because Brazil was, until the first decade of the twentieth century, the only major exporter of latex, a product in ascendent demand after the discovery of the vulcanization process, the rubber barons reaped immense profits from this trade.[8]

Yet, the rubber barons' splendor was short-lived. Hevea seedlings smuggled out of Brazil to Kew Gardens and thence to Malaysia came into production in the years immediately preceding World War I. In a matter of months, rubber prices dropped precipitously in the international market, devastating the fortunes of the Amazonian gentry. Latex production continued, however, for a much constricted domestic market, with prices maintained by the federal government at a level which enabled extractive production to continue. Despite efforts to promote plantation production of Hevea in Brazil,[9] the trees soon fell prey to a leaf fungus which destroyed them. This fungus did not affect sparse rubber trees in species diverse forests, and was nonexistent in Southeast Asia.

Production relations in Brazilian rubber production to this day are little altered; the principal change is that, in many cases, gatherers' dependence on concessionaires has been replaced by ties to merchants. Reliance on merchant credit

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[8] The extent of the wealth created is symbolized by the Manaus Opera House, built of marble and tiles entirely imported from Europe, which in its heyday boasted performances by such artists as Enrico Caruso and Sarah Bernhardt.

[9] The ill-fated venture of Henry Ford at Fordlandia in the heart of the Amazon is the most widely known case of failure in Brazilian rubber planting.

and marketing services is a feature common to many extractive products in Brazil and other tropical regions, even where the producer has some control over the physical resource. While the producer gains some autonomy through legitimation of usufruct to the resource, he is still highly vulnerable to the vagaries of the market and to monopsony exercised by those who control trade.

When new producing or processing technology is developed, such as in the case of rubber and that of babassu described in this study, those dependent on the resource to furnish cash or in-kind exchange for goods necessary to their survival are severely affected. With a number of extractive products, gatherers rely for a considerable proportion of their incomes upon the sale or trade of these commodities. It is difficult for them to quickly adjust their labor or land allocation among other activities in areas where extractive resources predominate. The shift from collection of native plant resources to annual crop cultivation or livestock husbandry is drastic for people who may have little experience with the crops or management practices appropriate to the area.

Placing reliance on the essential adaptability of humans to their environment (Norgaard, 1984) is one answer to adjustments required by those dependent on extractive resources. Producers will adapt to shifts in markets for extractive products. Such adaptability, however, does not guarantee responsiveness to exogenous conditions which may result in resources being depleted through property rights delimitation.

Property Rights and Extractive Resources

Native plant resources are often subject to pressures of over-exploitation. These may result in cases where rapid growth in demand causes a real increase in product prices, or where the population dependent on the resource grows at a rate exceeding the ability of the resource to regenerate.
Modern resource economics has tended to place the blame for resource depletion on an insufficient measure of individual control over resource use exercised through property rights. Privatization is neoclassical economics[1] usual prescription where open access resources are being depleted. Contradicting this view, a forceful swing toward barred-entry resources concentrated in the hands of a few has often increased rather than reduced the rate of resource exploitation (Repetto and Holmes, 1983). Property rights delimitation may also result in population pressures on limited remaining resources traditionally managed in common, thus hastening their depletion. Such results I define below as a tragedy of the non-commons.

The **Property Rights Controversy**

No "right" exists without social institutions to defend it. Each society creates unique institutions and working rules to define and defend property. In fact, the concept of property itself lacks any meaning outside a social context of relations between people (Veblen, 1898). Property rights have been defined as "sanctioned behavioral relations among men that arise from the existence of things and pertain to their use" (Furubotn and Pejovich, 1972:1139). However, "things" should not be narrowly limited to material objects, but also to intangible qualities not necessarily exchanged in the marketplace. Similarly, the concept of "use" ascribed to property rights by different societies varies widely, and should not be constrained to profit-making ends.

The institutional economists proposed that the particular institutions devised to articulate and protect property rights in a given society have arisen from conflict between self-interested individuals in the context of private property; these institutions have evolved so as to create a context for resolving such conflicts, providing "security for some claims and aspirations" (Randall, 1978, citing Commons, 1934). At the core of the conflict resolution process are transactions which involve "alienation and acquisition of the rights of property and liberty created by society" (Randall, 1978:3). Working rules for resolving conflicts through transactions are the result of "deliberate collective action." Such rules include the rights themselves, the duties that such rights impose on others, and the limits and responsibilities of the right holder as defined by liabilities imposed through powers vested in the state. But how can those in power be expected to set liabilities so as to resolve competing demands on resources?

Neoclassical welfare economic theory focused for some time on developing a general equilibrium framework for analysis of public goods provision. This framework assumes that a social welfare function, aggregating the individual utility curves of all consumers, can guide public decision-making with respect to nonmarket goods. Even if it were possible to estimate the form of a social welfare function,[10] however, difficulties in determining its role in decision-making have frustrated the general equilibrium approach to the problem.

Particular problems were found in devising economic theory to guide decision-making regarding public goods having "open access" characteristics. Such goods are those in which flows of benefits or costs are not restricted to individual actors because the resources from which the goods are derived are themselves unbounded or the benefits or costs flowing from them are indivisible, and hence not easily traced as regards their effects or source. Typical examples of such resources are air, fisheries, and underground aquifers. The negative or positive effects of one such resource user's action on another person —user or nonuser — are termed "externalities."

The "Property Rights (PR) School" in neoclassical micro-economic theory (described by Runge, 1984 as the "New Resource Economics") has emerged with a different approach to resolve open access resource problems. The PR school shies away from the issue of social welfare maximization in favor of two-party bargaining to achieve a constrained partial equilibrium.

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[10] The inherent "impossibility" under certain conditions of deducing a coherent social decision rule by aggregating individual preferences was shown by Arrow (1949).

Assuming away an admittedly shaky social welfare function, they also avoid questions of equity and fairness in either the initial distribution of income or that which arises from a given resource investment.

Scholars espousing the PR paradigm suggest that most if not all problems associated with open access resources can be resolved through market mechanisms. All that needs to be done is to define the liability rules for damages accruing from use of the resource, and an equilibrium solution is assured at the point where the marginal benefit to the user of the resource is equal to the marginal cost to the parties injured by the user's action. If the acting party is liable, he will be required to compensate the injured party with a sum at least equal to the marginal cost he causes from the externality he has generated. Rather than make compensatory payments, he will "internalize" the externality if the cost to cease causing the downstream impact is less than the minimum payment necessary, provided cost-minimizing technology is available.

If liability does not fall on the acting party, however, the injured party or parties to the externality must pay its producer to compensate his cost if they desire its abatement. The result in the simple two party case is symmetrical in terms of results. This approach, first formulated by Coase (1960), requires the condition that there be no costs in making transactions between acting and injured parties to an externality. Likewise, the theory presupposes no difference in the budget constraints of the parties, so that compensatory payments will not alter the ex ante income distribution, regardless of the liability rule. This assumption enables theorists to posit that the end result of a market solution to externalities would be Pareto-optimal: those who make compensatory payments will not be made worse-off by shouldering the cost, regardless of who is made liable, i.e., who is awarded the property rights.

Yet, as Randall (1972) shows, neither are transactions costless, nor are budget constraints unaffected by liability rules. Furthermore, the results are not symmetrical: it does matter on which party liability is placed. Only where the liability is placed fully upon the producer of the externality will there be a result approximating the Pareto-optimal case. However, it is rare that liability will be placed on the producers of externalities in an open access resource situation, either because they are difficult to identify, or because administrators "contribute, foster, aid and indeed legitimate the special claims of small but highly organized groups to differential access to tangible resources which are extracted from the commons" (Crowe, 1969:1106). Those who sustain the injury must pay the price. But those affected are typically many, and the transactions involved in obtaining contributions to a pool are so costly as to exceed the benefits to be obtained. Alternatively, affected parties might organize to seek a change in the (liability) rules of the game. Yet, the organizational solutions to externality problems are themselves public goods which are prone to free ridership and noncontributive behavior (Olson, 1964).

Paradoxically, the "commons" tragedy exposed by Hardin (1968) provides grist for the mill of both those favoring privatization of natural resources as well as those favoring coercive regulatory power in the hands of the state as the only means to avert overexploitation (Runge, 1984). In resolving environmental externalities in the developed countries, popular opinion and political action have tended to favor a government standard-setting role rather than rely on privatization and the magic of the marketplace.

Despite the obvious difficulties in achieving market solutions to externalities, PR scholars persist as proponents of private property over resources as the only means for ensuring efficient economic behavior. "Attenuation" of private property rights — or deviation from fully unilateral decisionmaking power with respect to resource use — is anathema to the PR school. The attenuation of property rights in reality implies a redistribution of wealth (Schmid, 1976), because the modification of total individual control over resources to incorporate social as well as private costs will mean that some of the benefits of resource exploitation will be retained by society (or the state, acting on behalf of societal claims). Scholars of the PR approach interpret such societal restraint on full freedom of individual property exploitation as "rent seeking behavior." A ruling elite would be poorly predisposed to allow a shift in property rights or liability to favor those not in power. It is not surprising, therefore, that most PR theorizing generates results strongly biased toward the status quo, or toward private property rights creation in cases where "attenuated" rights have been or threaten to become entrenched.

The Tragedy of the Non-Commons

Ownership of land can confer the power to withhold land from production (Taylor, 1978). Such a power can lead to increased pressure on remaining land resources that were traditionally managed for sustained yield as common property. Where resources have been privatized so as to curtail benefits obtained through common management and those excluded are not backed by a liability rule enabling them to exact compensation from the producer of the external costs, there exists what I call a "tragedy of the non-commons."

The enclosure movement in England that took place from the seventeenth to the nineteenth centuries provides one well-researched example of a non-commons tragedy. Overgrazing was not the cause of the enclosure movement, as Hardin (1968) and others would like us to believe. Regulation of stocking rates on the common fields was generally practiced, through requirement of a home feedbase during non-grazing periods and at night (Tate, 1967). Rather, the increased profitability to the English manorial lord of sheep production for wool at the onset of technological development in the textile industry led to the enclosure of the commons. Such enclosure is widely documented as having resulted in severe rural immiseration, and forced many to migrate to cities where they created what Marx called the "reserve army of the unemployed," whose downward pressure on wages helped stimulate the industrial revolution. In France at the close of the feudal era, a similar process occurred:

> as forest lands became increasingly profitable as sources of timber for sale vis-a-vis their traditional role as sources of livestock forage, firewood for home consumption, and building material for the peasant village, the feudal lords changed from administrators and protectors to profit-seeking entrepreneurs. . . . The result was a weakening of the village system and dispossession of the peasantry. The peasant was transformed from a co-equal owner on the commons with secure tenure to a landless worker on the feudal estate. This is the true 'tragedy of the commons.'
>
> (Ciriacy-Wantrup and Bishop, 1975:720).

Similar enclosures are underway in many developing countries today where those who formerly managed resources in common are rapidly being excluded. Resources treated by PR economists as "no-one's property" and hence subject to external costs, are often in fact regulated by common property institutions so as to avert externalities. The costs of demolishing such institutions and replacing them with private property are often inequitably shared.

To combat inequities arising from resource exclusion, decision-makers may require some demonstration that such resources are in fact used for economic benefit. Among common property institutions that have enabled long-term sustainment of resource productivity are traditional range management techniques for the high Andean grasslands (Orlove, 1975;

1977), the Swiss Alpine herding system (Netting, 1976), and some African pastoral systems (Gilles and Jamtgaard, 1981). It may not be enough to support efficient communal management of resources, however. For example, shifting cultivators in Indonesia may need to devise a signature of ownership to assure continued exercise of collectively-sanctioned control over forest fallows, as a legal lever against the State's expropriation of land to benefit timber corporations (Dove, 1983) . The babassu palm case in Brazil is one where the beneficial characteristics of common resource management need to be assessed against purported efficiency gains from land use change and industrial technology innovation.

Rights to use land on collective properties of the babassu zone are allocated by communal consent (Moura Sá, 1975; Soares, 1981). Each household is considered to possess harvest exclusivity over the palms in the immediate surroundings of its dwelling no matter who has title to the land. Additionally, shifting cultivators possess usufruct to fallow cycle products of the plots on which they cultivate annual crops. This gives them an incentive to retain babassu palms and other useful plant species which will provide essential goods and services during the fallow (May et al., 1985a).

On traditional private estates in the babassu zone, residents on a given property (moradores) are granted exclusive usufruct to the babassu palms that grow there, on the condition that the kernels they extract are sold through the landowner. Charcoal that they produce from babassu fruit husks and numerous other subsistence products derived from the palms are part of their property rights held in common with other moradores. Those who are granted such rights are consequently motivated to exclude others from trespassing to collect fruits or other goods from the property, thus sustaining resource productivity.

How has babassu preservation emerged as a non-commons problem? Large landowners supply a strategic share of the babassu kernels used to sustain a major oil industry. However, many landowners are engaged in palm deforestation in order to establish improved pastures. The conversion of large areas of the babassu zone to pastures also implies a reduction in labor use in agriculture and has resulted in expulsion of peasants from traditional estates, commonly managed lands and unclaimed frontier territories.

A landowner, in eliminating a portion of his babassu reserves, assumes that his action will not affect demand for kernel, but the cumulative effect of deforestation may hasten the downfall of the oil industry. This is so because at some point the increased cost of transport and locating secure supplies imposed by palm removal will exceed the price that oil pressers are able to pay given the nature of final demand. This process results in a traditional "commons" problem, since individual ranchers do not bear the external cost of their palm clearing activities sustained by the industry as a whole. At the same time, shifting cultivators, deprived of land sufficient for fallow cycles to permit regrowth of babassu leaves, are now being forced to cut the very palms on which they depend for an important share of their incomes. Privatization has generated a non-commons tragedy as well as a commons tragedy.

The answer provided by those proposing a technical solution to the babassu problem is to develop industrial technology that will allow a more thorough utilization of babassu by-products. This will purportedly enable the industry to pay enough for the fruit that landowners will no longer deforest the palms. But this solution also generates a non-commons tragedy. By selling whole fruit rather than the kernels produced by peasants in local cottage industries, the landowner will be able to appropriate a larger share of the price. He will need peasants only for the harvesting of fruit, a seasonal activity; there will be no need to secure a permanent resident laborforce. Fruit harvesting requires vastly fewer workers than the current cottage industry, so the number of workers employed would be much smaller. This innovation thus has the potential to cause considerable labor displacement. This outcome is the result from either palm deforestation or technical innovation in the babassu processing industry. Both effect exclusion from property rights formerly held by peasants. The chances that those displaced will be absorbed by other sectors of the regional economy are poor, given the highly capital-intensive pattern of rural and urban investment. The only alternative is emigration to already overcrowded cities or the rapidly closing Amazonian frontier.

The PR formulation of transactions between producers and victims of externalities suggests that gainers will compensate losers. There are several considerations that undermine the validity of this reasoning in the tragedy of the non-commons. First is the obvious fact, patent in the babassu case, that bargaining power is unequal. Given an inequitable prior distribution of property rights, landowners are under no pressure to compensate peasants' losses from babassu eradication. Peasants lack the political cohesion of small groups necessary to effectively mount an organized movement that will force a change in the rules of the game.

Second, there exists the possibility that the total external costs exceed the total gain from industrial innovation, thus leaving no way to compensate the losers from the proceeds of the action causing the externality. The result in such a case would not be economically efficient, because the gainers could not compensate the losers even if they wanted to. This would occur, for example, if the negative distributional income effects of a shift to mechanical whole fruit processing in babassu were to be greater in magnitude than the incremental income generated by the change. Those displaced could not then be adequately compensated from the industry's gains from innovation, or by the increased consumers' surplus obtained by a long-term reduction in average production costs.

Finally, the negative distributional effects of technical innovation undermine the basic assumption of compensation theory that the results of market solutions to externality problems are symmetrical regardless the liability rule. If peasant incomes are eroded by changes in property rights and in technology, an assessment of the returns from technical innovation would be incapable of accurately reflecting demand and supply since some producers' budget constraints will have been reduced.

Conclusions

This chapter has provided an overview of the roles of secondary successional forests, particularly those composed of palms, in economic strategies of shifting cultivators in the tropics. Palm forests have emerged in the babassu zone in succession after clearing for shifting cultivation. Besides supplying nutrients to the soil after slashing and burning the palms' leaves, productive adult palms retained in the crop field continue to provide a range of important cash and subsistence products during the fallow. Such strategies are becoming increasingly necessary since peasants' survival as agriculturalists alone is no longer tenable in many developing countries. Landless and near-landless agriculturalists are forced to turn to wage labor and extractive resources as a means for making ends meet.

Among the reasons that secondary successional resources and extractive activities have not enjoyed broader acclaim among development practitioners is that, historically, such resources have been exploited in socially unattractive ways. The case of rubber tapping in Brazil exemplifies the relations of near debt peonage suffered by those engaged in supplying latex to world markets. This example brings us to the central thrust of the thesis, i.e., that property rights exercised over natural resources determine the partitioning of returns from their exploitation.

Analysis of the process of market expansion for extractive resources under open access conditions suggests that resource depletion and possibly extinction may result from unfettered growth in product extraction from native plants. Such resource pressures could be brought about in response to a boom in market demand, or to delimitation in property rights. Innovation in agro-industries or synthetic processes can eventually satisfy demand while redressing the ecological imbalance, but rural labor engaged in the extractive industry is likely to be displaced as a result. The initial distribution of property rights affects the partitioning of benefits from innovation.

The tendency among resource economists of late has been to prescribe privatization as an institutional device to avert resource depletion, on the assumption that a market solution to externalities will achieve Pareto-optimal results. The approach of the PR school is to defend full individual autonomy regarding use of resources against a state which seeks rents derived through "attenuation" of property rights.

However, as Schmid reminds us in his critique of the PR approach: "one man's attenuated rights are another's bread" (Schmid, 1976: 476). In the babassu case, privatization of access to land and palms as well as innovation in industrial process technology will displace peasants who are unlikely to be compensated through employment in other sectors. The result is a tragedy of the non-commons.

This analysis suggests that the net benefits to society from agro-industrial change are not unambiguously positive. Distributional costs may result without prospects for market directed compensation, even where net social welfare is positive. The prospects for compensation through redistributional policies depend upon the ability of those displaced by property rights alienation to effectively bargain for a rule change. Where those harmed by agrarian change constitute a large "diffuse" peasantry in a society dominated by landed elites, conventional political channels are inappropriate. The response by frustrated and powerless peasants threatened with loss in property rights has thus been to exact violent retribution rather than patiently await a change in regimes. To redress negative distributional consequences of agrarian change through constitutional means rather than violent struggle depends upon organizational strategies empowering peasants so that they may make effective political claims. Only in this way will rewards from agro-industrial innovation be equitably distributed.

CHAPTER III

THE BABASSU ZONE: HISTORY AND CHARACTER

Physical Geography of the Babassu Zone

Although babassu occurs in other parts of Brazil (Figure 3.1), the major area of the palm's occurrence and economic significance lies in part of what is called the Mid-North region, comprised of the states of Maranhão and Piaui. Over 80 percent of commercialized babassu kernel originates in this region (IBGE, 1984b), where a major industry based on extracting oil from these kernels is concentrated (Table 3.1).

The babassu zone that is the focus of this study includes lowland areas of Maranhão north of a dissected plateau which lies 6° south of the equator.[1] This region is bounded on the north by the Atlantic Ocean, on the east by the Parnaiba River which separates Maranhão from Piaui, and on the west by the Amazon frontier, at about 46° W., where dense babassu stands give way to humid tropical forests composed of broadleaved hardwoods. In this zone, babassu palms occupy a greater proportion of overall land area, and are a source of employment for more people than in any other part of Brazil. Most of the industrial facilities engaged in extraction of babassu kernel oil operate in this zone (see Chapter VII). It is estimated that some 300,000 rural households in Maranhao

[1] While considerable reconnaissance work was accomplished in the portions of the babassu zone which lie within Piaui, as well as in Maranhão, where the principal survey work was carried out, it would be pretentious to generalize the study's findings to the entire Mid-North region.

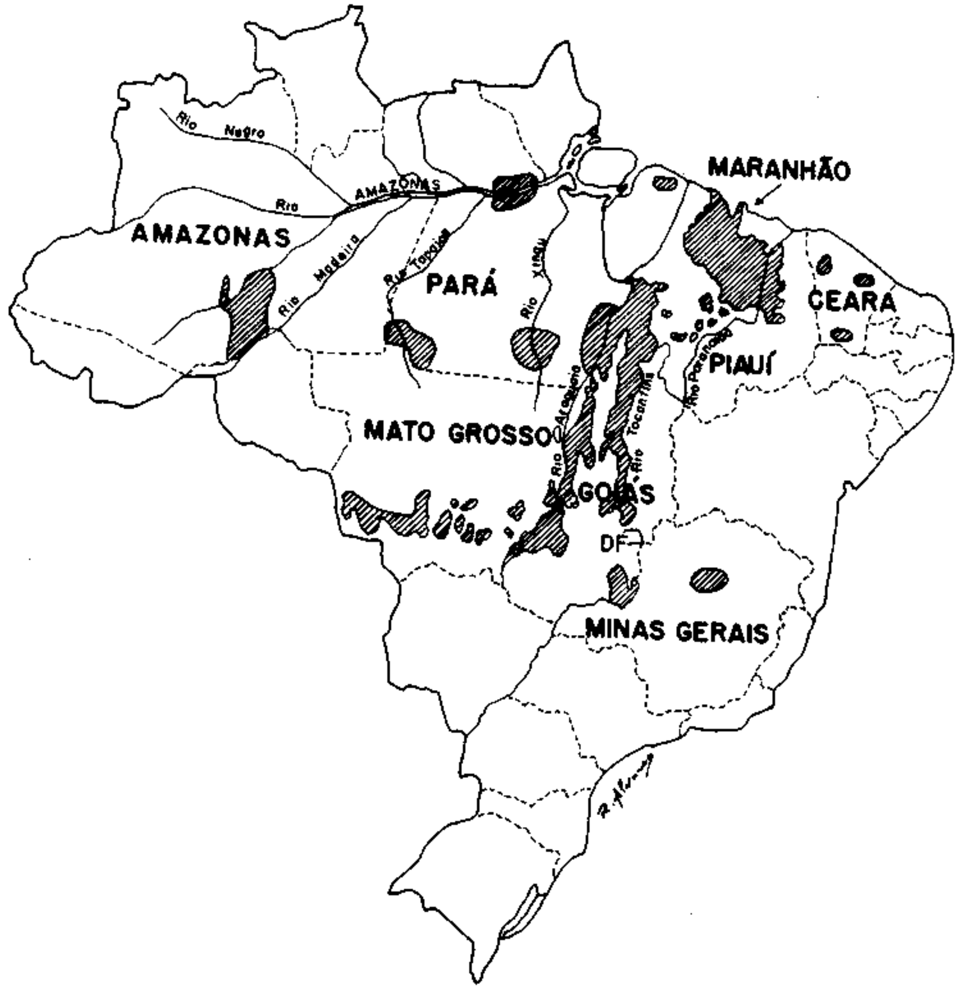

Figure 3.1. Areas of babassu occurrence in Brazil (May et al., 1985a).

Table 3.1. Babassu coverage area and level of commercial exploitation in Mid-North Brazil (MIC/STI, 1982; IBGE, 1984b, respectively).

STATE	AREA IN BABASSU STANDS		KERNELS MARKETED (1980)	
	km²	%	tons	%
Maranhão	103,040	53	183,455	73
Piauí	19,780	10	20,214	8
Mid-North	122,820	63	203,699	81
Other States	73,550	37	47,282	19
Brazil	196,370	100	250,951	100

alone are involved to some extent in extracting babassu kernels from their fruit (Kono, 1976; Mattar, 1979).

The babassu zone is one of bioclimatic transition between three radically distinct ecological regimes: Amazonian humid evergreen forests, savannas and woodlands (cerrado) of Brazil's central plateau, and semi-arid thorn scrub (caatinga) of Northeast Brazil. Annual mean temperatures in the area range from 20 - 27° C. Seasonal rainfall varies from 700-2100 mm annually (Golfari and Caser, 1977), 90 percent of which falls unimodally from January to June. Although most of the babassu zone is part of a sedimentary basin under 200 m. in altitude, palms are found at elevations up to 1000 m. in more mountainous areas. Babassu stands occupy over 100,000 km^2 in Maranhão, an area roughly the size of the state of Virginia, some on upland sites and others in galleries along valley bottoms. The palms grow in a variety of ecological sub-regions. The different subregions are most clearly described with reference to variations in seasonal precipitation in a rainfall gradient increasing from east to west (Figure 3.2). Babassu palms occur in differing degrees of coverage and productivity in these different areas (Figure 3.3), affected principally by water availability, soil characteristics, and topography.

Within the eastern dry cerrado (savanna) belt, where rainfall ranges between 700 and 1300 mm., babassu occurs predominantly in galleries along river banks whose alluvial sandy clays retain water during a six to eight-month dry

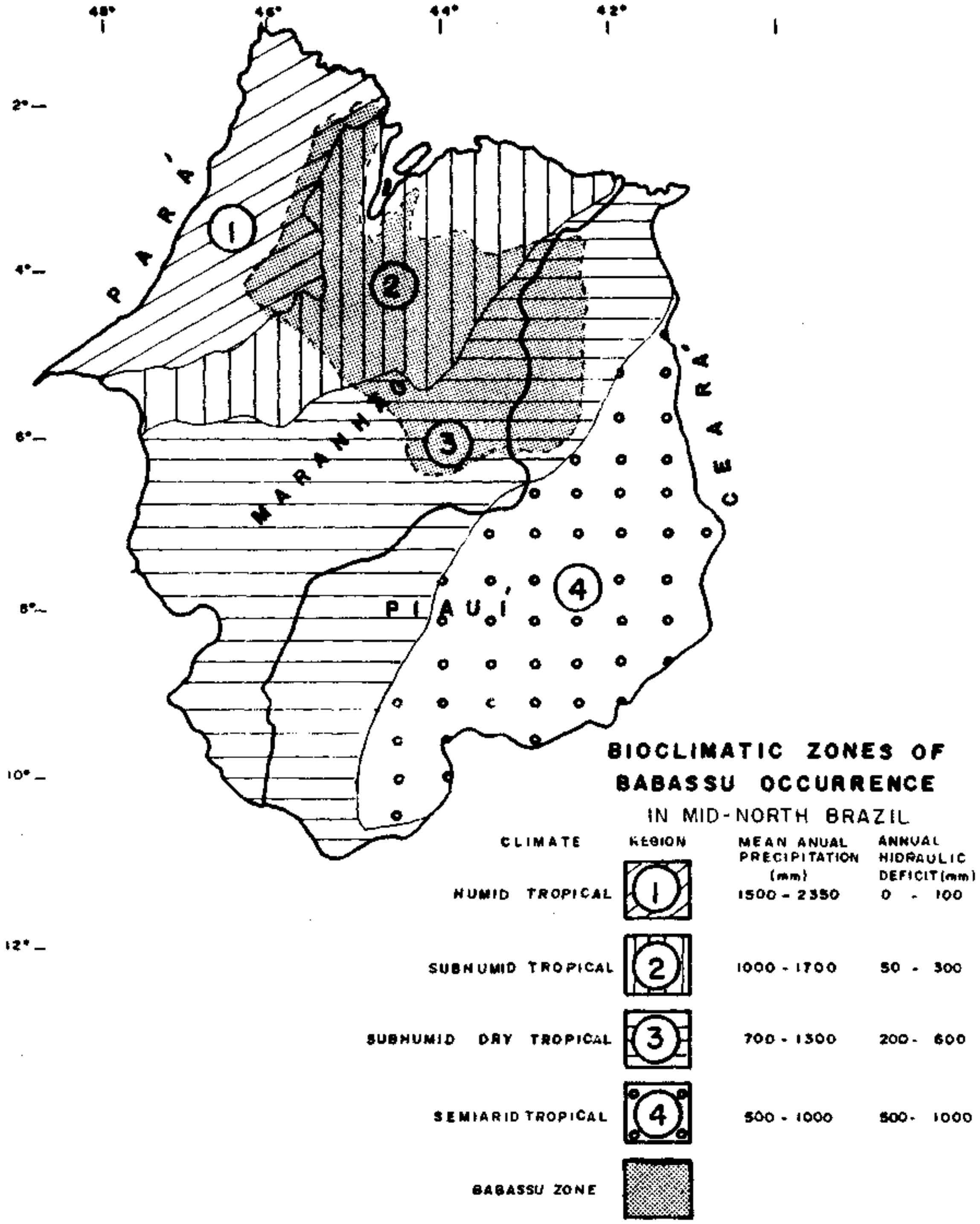

Figure 3.2. Bioclimatic zones of babassu occurrence in the Mid-North region of Brazil (after Golfari & Caser, 1977).

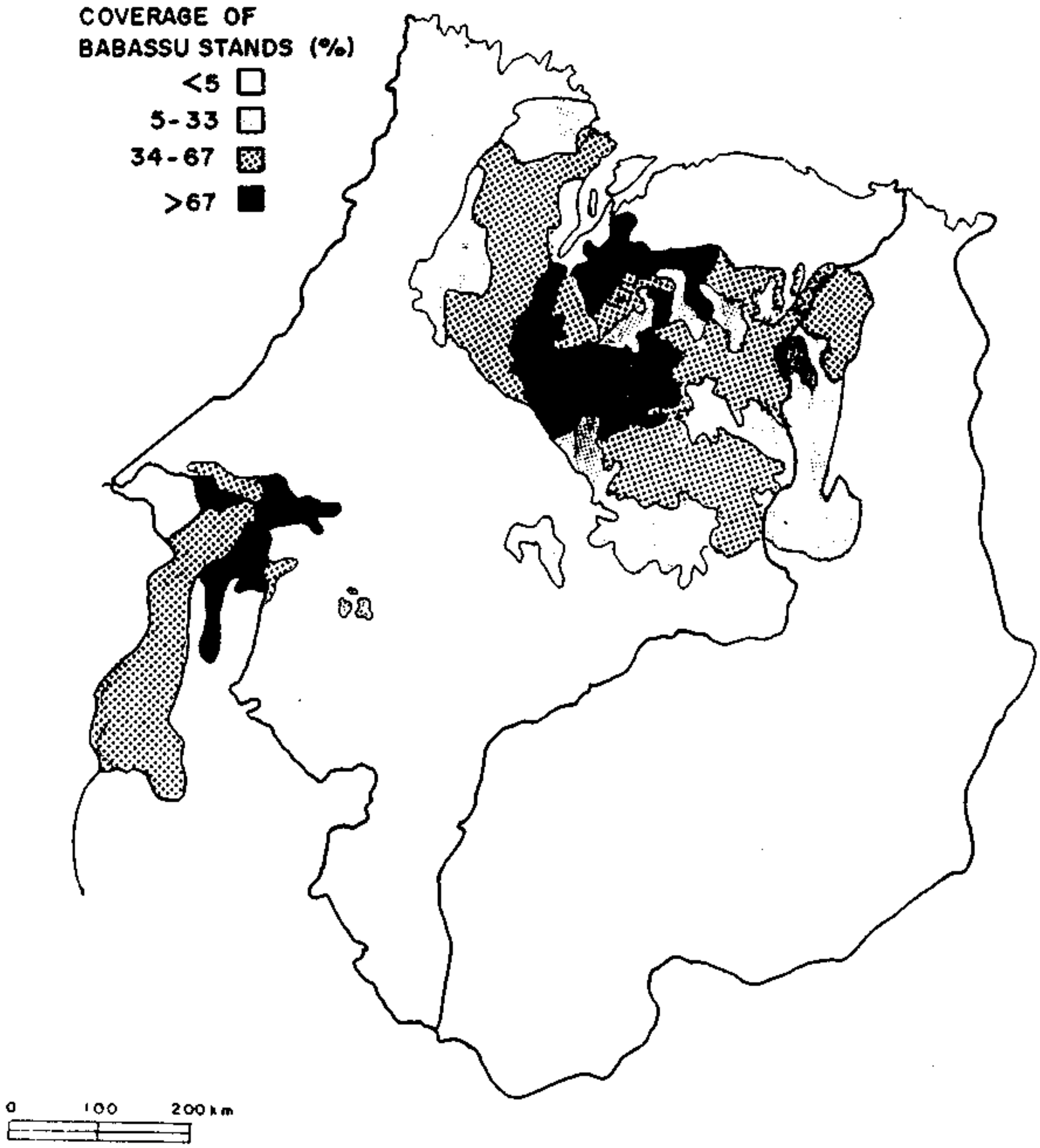

Figure 3.3. Babassu coverage density in the Mid-North region and northern Goiás (after Anderson & Anderson, 1983; MIC/STI, 1982).

season. Palm coverage densities in the cerrado overall average 44 percent in areas where the palm occurs (MIC/STI, 1982). Soils of the upland cerrado are deeply-weathered sandy laterites. Babassu is sparse on these dry lands, whose vegetation consists mainly of leguminous trees and scrub withcarnaúba (*Copernicia prunifera*) palms appearing over unimproved range. Cerrado geography extends to the north and westward following the course of the Itapecuru River until interrupted by river deltas surrounding the Bay of São Marcos on the Atlantic coast (Figure 3.4).

A more humid subregion having rainfall between 1500 and 1800 mm. lies to the west, where alluvial deposits from three major rivers have created well-structured alfisols with moderate phosphorous and nitrogen content, high cation exchange capacity and base saturation (SNLCS, 1984). Topography in this area is highly dissected; 60 percent of the land area is made up of inverted bowl-shaped hillsides having between six and 10 percent slopes. The most fertile soils lie at the foot and summit of these hills, while those on the hillsides are subject to severe erosion if disturbed (Seguy, 1982). Despite the relief, over two-thirds of overall land area are covered with babassu palms in this *cocais* (palm forest) subregion.

The seasonally flooded lowlands in the river delta region are known as the baixada. This subregion's low-lying terrain is inundated each year during the rainy season by the outlets of the region's major rivers. These lowlands are covered with

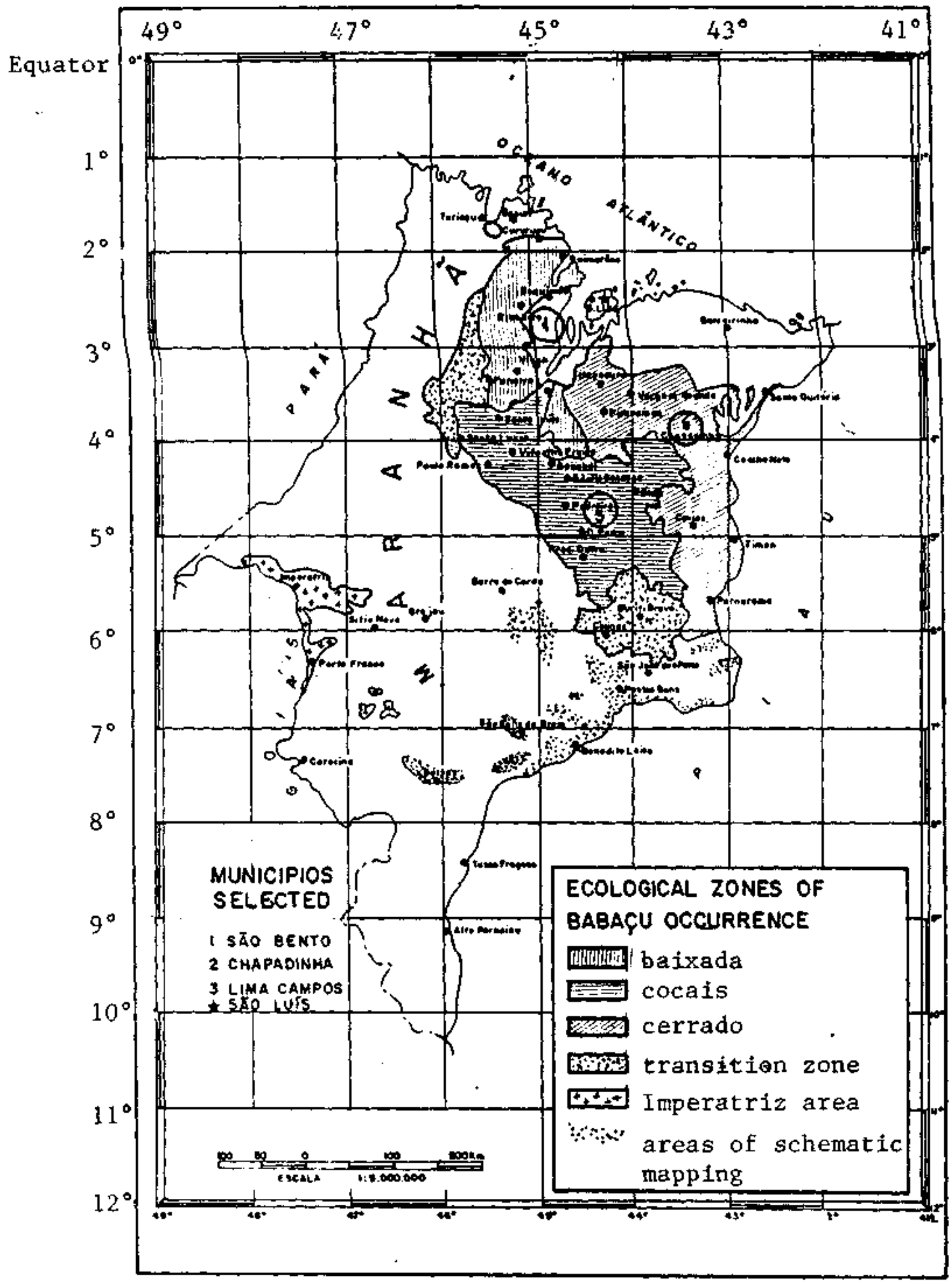

Figure 3.4. Ecological zones of babassu occurrence in the state of Maranhão (after SERNAT, 1981). Field study sites are marked with circles. Home base in São Luís is marked with a star.

native grasses which serve as common grazing land during the dry season. Babassu palms are dominant on "islands" within the open range.

The "Pre-Amazonic" zone, with annual precipitation between 1600 and 2100 mm., lies on Maranhão's western frontier. Here, patches of tropical moist forest are interspersed with young secondary forest (capoeira). Although only sparsely present as a component of species-diverse Amazonian forests, babassu rapidly becomes dominant once those forests are slashed and burned for shifting cultivation. Thus, while coverage densities average only 20 percent of the areas where babassu occurs, these stands are expanding as settlement encroaches on the frontier.

The palm forests did not always occupy such an extensive area as they do today; rather, they have generally formed on sites occupied by people. Babassu's capacity to dominate the landscape is due to its cryptogeal ("hidden") mode of germination, in which the growing point or apical meristem initially grows underground, remaining there until the stem emerges several years later. This adaptation permits juvenile palms to survive the cutting and burning associated with shifting cultivation. These palms, released from competition during the fallow, form high-density stands (Anderson, 1983). Relatively dense and continuous stands of mature babassu in the cocais thus indicate fairly stable human occupation, rather than solely favorable growing conditions for the palm. The borders of the cocais are hence indeterminate and expand-is currently accelerating.

This study focuses its attention on two principal areas of babassu occurrence and commercial exploitation: the cerrado and cocais of Maranhão. Land use practices in these two areas differ substantially, in line with precipitation and ecological associations. In the cerrado, subsistence long-cycle shifting cultivation is concentrated in pockets of humid bottomlands; most land is occupied by extensive grazing of unimproved beef cattle, goats and sheep; settlement is sparse, averaging only 12.2 inhabitants per square km. in 1980 (Table 3.2). In the cocais, in contrast, agriculture consists chiefly of short-cycle shifting cultivation interspersed with planted pastures for beef or dairy cattle, and some mechanized rice production. Rural population density in the cocais is more than double that of the cerrado. However, the density in relation to arable farmland differs only slightly between the two regions (Table 3.2); the allocation of increasing land areas to pasture in the cocais has constrained land available for shifting cultivation, augmenting the population pressure on remaining cultivable area. Communications have evolved in the babassu zone from strictly navigable river commerce to a trucking-dominated network today. Most of the interior territory is still only accessible by dirt roads and tracks, impassable except by animal during the rainy season. Of the two principal sub-regions, the cocais is better endowed in surface communications. Besides being traversed by three

Table 3.2. Population density by subregion, 1980 (IBGE, 1981; IBGE, 1984a).

Subregion	Rural Population per km^2	Rural Population per km^2 of arable land in farms[a]
Cerrado[b]	12.2	26.7
Cocais[c]	25.0	28.2
Babassu Zone[d]	16.4	27.2

[a] Includes all land in farms except native pastures, forests and other lands not classified as suitable for agriculture.

[b] Includes the Itapecuru and Alto Munim microregions, *sensu* IBGE (1981).

[c] Includes the Mearim and Medio Mearim microregions, *sensu* IBGE (1981).

[d] Weighted by relative area of subregions.

major navigable waterways, federal highways now cross the cocais, bound for the Trans-Amazon highway, Brasilia, Belém, and Northeast capitals (Figure 3.5).

The people who live in the babassu zone today are descendants of Portuguese and other European settlers who intermarried with Indians and Black slaves. This rich and varied blend of races and cultures has yielded a rural population called *caboclo*.

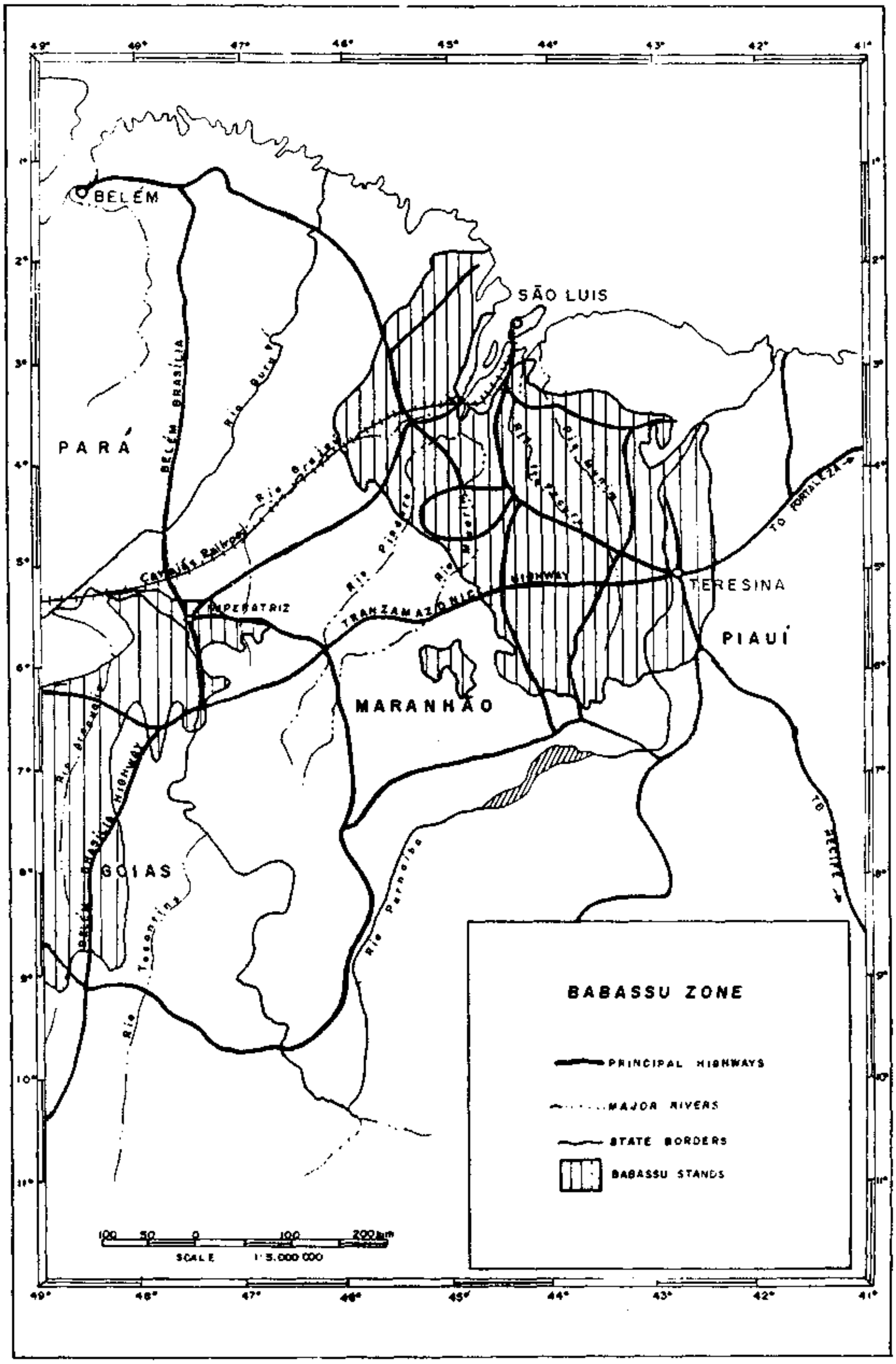

Figure 3.5. Rivers, highways, and the Carajás railroad line in the babassu zone.

Commodity Cycles and Frontier Expansion

The history of the babassu zone parallels that of Brazil as a whole in being one of commodity cycles and frontier expansion rather than productivity growth in agriculture. Colonial occupation began in the early seventeenth century, when the French were the first to establish a foothold on the island of São Luis, now the capital of Maranhão. Extractive products bought from Indians for transport to Europe were the initial lure of the eastern Amazon. With establishment of administrative/religious settlements by the Portuguese to protect territory and control sources of goods, colonists began to arrive in the region.

The region was occupied at the time of colonization by several Indian societies. As colonists arrived, Indians were gradually decimated through disease and aggression. Frontiersmen gradually expanded migratory cattle herding from the coasts of the Northeast states of Pernambuco and Bahia into the savannas between the forested hill ranges dividing the states of Ceara and Piaui from the fertile valleys of Maranhao. Property rights were established according to the law of *usucapiao*. which held that "property belongs to he who uses it," a philosophy which defined frontier claims then and today. Similarly, the signature of occupancy that constituted a valid basis to secure property control was one of violent expropriation.

Indian tribes such as the Tupinambá and Timbira had established settlements and identified their territorial rights in relation to groves of wild palms which occurred in galleries along streambanks and alluvium. Babassu and buriti (Mauritia flexuosa) palms were the most important of these, serving as a hedge against famine, and also providing fuel and fiber (Steward, 1963). After ridding the new lands of the Indians, colonists also established homesteads on the fertile bottomlands and learned to make use of the palms.

In the late 18th Century, the Portuguese Companhia Comercial do Maranhão e Grande Pará (a state trading monopoly) stimulated production of tropical crops suited for the region which offered potential for increased demand in the European metropolis (Nunes Dias, 1970). The principal crops were sugar cane and, later, cotton grown in slave plantations for which Africans were imported in large numbers. Plantations were established according to a continually shifting pattern, encroaching on uplands away from the initially settled navigable streams as soils were depleted (Andrade, 1978). As they moved, the abandoned lands were colonized by babassu palms.[2]

The Cotton Cycle and the Rise of the Babassu Industry

Cotton grown in Maranhão occupied an important place in international trade during the 19th Century. This cotton had similar characteristics to short-fibered varieties of the

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[2] The first reference to the now extensive monospecific forests of babassu palms in Maranhão is found in an 1820 work cited by Abreu (1928), which suggests that the now dense stands emerged only after the decline of the plantation cycle in Maranhão.

American South. During the disruptions of the War of 1812 and the U.S. Civil War, Maranhão's exports peaked. Slave-produced cotton grown on remote infertile soils could not compete long with the post-bellum Southern United States, however, and the plantation society soon entered into decay. The cotton boom during the heyday of Maranhão's colonial development led in its subsequent bust to what has been described as a "decadent" agriculture (Wagner, 1984).[3]

Responding to unfavorable terms of trade in cotton, and after abolition of slavery in 1888 depopulated the plantations, regional landholders shifted their capital into commerce. Their estates drifted into semi-feudal production of wage foods and cotton grown on dispersed sites by sharecroppers and renters who supplied a regional textile industry which survived into the 20th century. Former slaves and others who were drawn to the region's interior became squatters occupying untitled lands in the alluvial valleys on the Amazonian frontier.

As the Southeastern Brazilian agro-industrial complex took off in the early Twentieth Century, the babassu zone was unable to compete with southern cotton or textiles; cotton ceased to be grown widely after the late 1950s. Regional merchants and industrialists gradually replaced their ailing investments in textiles with vegetable oil processing and

[3] This cycle gave grist to André Gunder Frank's theory of "development of underdevelopment"; the decline of Maranhão's agriculture in the late 19th Century is one of the supporting cases used to support dependency theory (Frank, 1967:159).

trade with occupants of remote properties. Babassu kernels and rice became the principal commodities exchanged for industrialized goods from the urban south.

The babassu oil industry began to prosper in the 1930s as a result of increased demand for lauric oils in international markets. The babassu zone's role in this industry was at first primarily as an exporter of kernels to other countries or to the Southeast of Brazil, where the oil was extracted and exported. Babassu was particularly important in international trade immediately before and during the Second World War, when Philippine copra shipping was cut off by Japanese occupation.

As Brazil's industrial complex expanded further in the south, and as other lauric oils (from coconut and African oil palm kernel in particular) rebounded from the scarcities of the war years, domestic consumption of babassu oil by soap and cosmetics manufacturers supplanted the export trade. Babassu oil and press cake became the principal exports of the state of Maranhão after 1962, when increasing transport costs for kernels and fiscal incentives made it attractive to install oil extraction facilities in the babassu zone itself. By 1980, there were over 30 functioning oil factories in Maranhão, providing crude oil for domestic consumption and press cake or meal primarily for export. Until as recently as 1977, this industry contributed the largest single source of value-added tax revenues in the state; babassu kernels are

Table 3.3. Proportional value of principal products,[a] Maranhão: 1974 - 1977 average (Mendes, 1979).

PRODUCT	%
Babassu kernel and industrial products[b]	54.7
Unhulled rice	32.0
Wood	6.3
Beef cattle	3.3
Cassava meal	2.4
Maize	1.3
Principal Products	100.0

[a] Values are based on prices declared for value-added taxation (ICM).

[b] Costs of kernel excluded from value of finished products.

still second only to rice in gross agricultural product value (Table 3.3), in an economy still based in large part on the primary sector (Table 3.4).[4] Babassu oil production in Maranhão is estimated at nearly 100,000 metric tons annually, crushed from kernels gathered and extracted entirely from native stands by peasant farm families.

[4] Since 1980, contractions in the babassu oil sector, drought effects on rice output, and growth in agro-industrial activity at the frontier have reportedly enabled timber to replace both babassu kernels and rice as the prime generator of value-added taxes in Maranhão.

Table 3.4. Proportional distribution of net internal product estimated at factor cost in 1980 current prices (SUDENE, 1984).

(percent)

SECTOR/REGION	MARANHÃO	NORTHEAST BRAZIL	BRAZIL
Agriculture	41.9	18.5	13.0
Industry	14.4	27.4	34.0
Services	43.7	54.2	53.0
Total	100.0	100.0	100.0

Table 3.5. Relative welfare status: Maranhão, Northeast Brazil, and Brazil (SUDENE, 1984). All figures refer to 1980, unless otherwise mentioned.

INDICATOR/REGION	MARANHÃO	NORTHEAST BRAZIL	BRAZIL
(1) Per-capita net internal product (Cr$)	24,705	45,972	93,314
(1) as % of Northeast	53.7%	100.0%	203.0%
(1) as % of Brazil	26.5%	49.3%	100.0%
Child mortality rate (per '000) - 1976	133.2	177.7	121.2
Adult illiteracy rate (% of pop. over 10 yrs.)	56.6%	46.5%	39.8%

As Table 3.5. shows, Maranhão is among the poorest states of Brazil, with per capita net internal product only one-quarter that of Brazil as a whole, and half that of Brazil's Northeast, secularly the poorest region of the country. Child mortality, an important indicator of health and nutrition, is not as severe in Maranhão as in the rest of the Northeast region, however, though it is slightly more severe than that of Brazil as a whole. Though the proportion of the population living in poverty is high in Maranhão, better general agricultural production conditions in the state's seasonally moist interior insulate the rural poor from the drought-induced famine common in much of the Northeast. Nevertheless, illiteracy rates, closely linked with child nutrition and overall welfare, are officially measured at 61 percent of the rural population in Maranhão over ten years of age, which is the highest rate in Brazil (IBGE, 1984b).

The Economic Miracle Comes to Maranhão

Agriculture in the babassu zone is still primitive, but conditions are changing rapidly as a result of externally introduced forces. As early as 1958, the federal planning agency for the Northeast of Brazil, SUDENE,[5] saw in Maranhão an immediate answer within its own jurisdiction for releasing the population pressure of the semi-arid Northeast and supplying wage foods for industrial workers on the coast (GTDN, 1978:59-63).

> Clearly, the opening of a supplementary agricultural front, costing relatively little, will help to solve the problem of food supply in the large urban centers where, it is probable, industries will have to be concentrated. With respect to the semi-arid region, the normal line of development will have to be in the direction of increasing dependence for

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[5] Superintendência para o Desenvolvimento do Nordeste do Brasil, a part of the Ministry of the Interior.

> foods produced outside the region, which will economically justify the opening of a new agricultural frontier... Colonization assumes the character of labor and land incorporation in a broader economic system, which presupposes links with consumer markets... The ultimate objective which we have in mind is to transfer from the semi-arid region several hundred thousand persons, to reduce demographic pressure and increase productivity, and move the agricultural frontier of the Northeast ... to promote an organized immigration flow in the direction of the interior of Maranhão and ... other regions on the periphery of the [drought] Polygon, where road infrastructure already exists or is under construction...

While colonization schemes have not achieved their promise, spontaneous westward migrations from Ceará and Piaui swelled the rural population of the babassu zone since the calamitous drought of 1957, occupying the heretofore sparsely settled river valleys of central and western Maranhão at the Amazon frontier. By 1980, Maranhão's population included nearly one-half million migrants from other states, 89 percent of whom were from the dry Northeast. The majority of these migrants settled in the cocais and Pre-Amazonic zones (IBGE, 1981).[6]

As migrants entered from the dry Northeast in successive waves, the region's common property resources were gradually curtailed and delimited, which has led to renewed westward migrations as well as rural-urban population shifts. Squatters on what had been public lands and former slaves who inherited abandoned plantations as community properties were

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[6] Of the migrants from Ceará and Piauí, 58 percent settled in four microregions: Mearim and Medio Mearim, Imperatriz, and Pindaré (IBGE, 1981).

later hemmed-in and in many cases robbed by land speculators who falsified titles. Land speculators and investors from outside of the region were attracted by Maranhão's low-cost land, and government subsidies for agro-industrial investment, applied principally to pasture establishment, herd improvement, and, more recently, sugarcane and tree plantations for cellulose. These developments, along with mineral ore extraction and aluminum processing projects linked with Amazonian integration plans, have brought Maranhão into the mainstream of Brazil's economic "miracle," which from the late 1960s to the mid-1970s spurred intense GNP growth but also worsened income distribution (Pfefferman & Webb, 1979).

Property concentration in Maranhão remains substantial. In 1980, 55 percent of agricultural land was controlled by one percent of the establishments on private estates over 500 ha. in size. At the same time, 85 percent of the establishments were held through rental, sharecropping, or squatting on land belonging to others or to the state, constituting altogether only nine percent of total agricultural land (IBGE, 1984a).

While net migration to Maranhão had been positive and dramatic for the previous two decades, the 1980 census reveals that the agricultural frontier no longer lies in the babassu zone (de Almeida, 1984): there was considerable out-migration between 1970 and 1980. Although immigration to Maranhão has continued, over one-half million people emigrated to other states, and net-migration was actually negative for the first time in recent history (Table 3.6). Settlers originating in

Maranhão are reported to have found their way to the remote reaches of western Amazonia and even to other Latin American countries.[7] Land in most of the settled areas of the babassu zone is now fairly rigidly controlled either in persisting latifundia, modernized ranches or medium/small farms. Whereas in the 1960s and 1970s there was still much land occupied by squatters, this category had almost disappeared from 1980 agricultural establishments. The opening-up of the eastern Amazon has further stimulated land speculation and pasture expansion, effectively cutting-off the frontier on the west to peasants expelled from the babassu zone.

Table 3.6. Population growth and net migration, Maranhão: 1950 - 1980 (IBGE, 1984b).

(thousand persons)

	1940	1950	1960	1970	1980
Population	1,235.2	1,583.2	2,469.4	2,992.7	3,996.4
Immigration	n.a.	161.1	450.0	406.3	456.2
Emigration	n.a.	100.2	163.2	263.5	505.8
Net migration	n.a.	60.9	286.8	142.8	(-) 49.6
% of pop. growth due to migration		17.5%	32.4%	27.3%	(-) 4.9%

[7] Wagner (1981a) cites newspaper reports that immigrants from Maranhão were expelled from the Orinoco River basin in Venezuela, where they were engaged in gold mining in the late 1970s.

In the 1980s, massive mineral resource extraction and processing projects were established, which have focused the regional economy on industrial infrastructure development, making agriculture a subsidiary priority. In an attempt to counter Brazil's foreign debt crisis, the government financed major hydroelectric, port and railroad infrastructure developments deep into the eastern Amazon along the Carajás range, to support iron and other mineral ore processing and export by multinational and state enterprises.

Rural-urban migration, which was already significant in Maranhão, has begun to cause serious burdens on urban services in the city of São Luis, as well as interior cities. A five-year drought in Northeast Brazil that began in 1979, and the lure of employment in industrial and infrastructure construction, exacerbated urban growth rates. While government officials have made enthusiastic forecasts of regional agricultural and forestry spinoffs from the multi-billion dollar investments in the mineral projects, the increase in urban food demands has not been met with efforts to integrate agricultural sector production or marketing stimuli with the Carajás corridor. Instead, livestock ranching remains the preferred land use for investors in rural enterprises.

Policy makers considering the future of the babassu zone now face a dilemma: Should the region simply develop as a service area for highly capital-intensive projects of external investors, or should they aim to secure a destiny based on sustained utilization of the region's natural resources?

Carajás project planners vacillate between priorities of moving ore alone, or dynamizing local food and extractive industries along the export corridor, to help defray the costs of railway construction with freight charges from food and timber. This interest in local resource development is keyed to the condition of international ore prices: when trade prospects are poor, local benefits take precedence as determinants of project viability; when high, such local considerations receive less priority.

Even should trade conditions prove propitious to a local resource development option for Maranhão, such a strategy will not necessarily benefit the majority of the region's poor inhabitants. The orientation of state policy regarding land use and property rights has sustained a highly skewed distribution of wealth and resources in the hands of a restricted elite. Local political power based on corporate coronelismo guarantees votes to the dominant machine in state party politics. While party names and figureheads have changed, the dominant group has remained that of landed property and mercantile interests. The history of government administration of agriculture and rural development in the babassu zone has demonstrated a bias toward those already wealthy (Tendler, 1980; Wagner, 1981a). It is therefore questionable what share of the purported benefits of resource development will fall to the landless peasants who are being expelled from lands in older settled regions, and who find it increasingly difficult to secure property rights on the rapidly closing frontier.

Site Selection and Data Collection Procedures

This study addresses distributional issues in resource development of the babassu zone of Maranhão. The potential for local resource development based in part on sustained utilization of native babassu palm forests makes this region one of particular interest. The objective of the study is to discern how changes in land use and babassu processing technology affect property rights and determine the welfare status of the region's peasantry. The research focuses on the interplay between different actors whose behavior will determine the partitioning of benefits from agrarian change and economic development.

Palm **Productivity vs. Extraction Rates: Alternative Hypotheses**

The babassu zone, as described in this chapter, covers an immense area. Its character of climatic and biophysical transition also makes for great variation in agro-ecological conditions. An analysis of production system characteristics and the effects of land use and property rights shifts must heed these variations in order to be generalizable to the entire region. Furthermore, different resource quality and locational variables enter forcefully into the decision framework of economic actors in babassu fruit marketing and processing networks. Parameters such as palm stand density, transport infrastructure, and the historical importance of babassu kernel production to rural enterprises are likely to affect the behavior of economic actors in the future vis à vis babassu forest management.

The field research program undertaken set out to meet this study's objectives within the time and budgetary constraints set by my sponsors, as well as to meet the concern of my local institutional affiliate for broad geographical applicability. In Maranhão, babassu palms occur in greatest density and are most important economically within three subregions: the cerrado, cocais, and baixada. As shown in Figure 3.4, these three areas are contiguous to one another and together occupy the majority of the babassu zone of Maranhão, constituting the areas of the state from which over 80 percent of kernel production originates.

The relative areas of babassu occurrence, average stand density, and productivity within each of the three subregions are shown in Table 3.8. The cocais exceeds both of the other areas both in terms of the proportion of area effectively covered with palms and the proportion of palms that are productive. On the other hand, the proportion of the estimated fruit production that is harvested for kernel extraction is far less in the cocais, while cerrado residents harvest over 60% of the subregion's fruit production. Baixada figures lie between the other two regions on most measures. Although the cerrado accounts for less than 22 percent of total estimated state fruit output, nearly 40 percent of the state's 1980 kernel production came from cerrado areas. In contrast, the cocais is the source of just under half of all state fruit output, but only 11 percent of this is exploited. If cocais residents exploited babassu forests at a rate approaching that of their neighbors in the cerrado, there would be a tremendous increase in babassu kernel output. It thus appears that there are substantial inter-regional differences in conditions affecting the amount of babassu fruit that are potentially harvestable and the amount that actually enters market channels in the form of kernels.

Table 3.8. Babassu fruit output and kernel extraction rates in Maranhão and three principal subregions (MIC/STI, 1982; IBGE, 1984b).

MEASURE/REGION	CERRADO	COCAIS	BAIXADA	MARANHAO
Area covered by stands ('000 km^2)	13.8	18.4	7.3	47.2
Average fruit yield per ha./yr. (tons)	1.24	2.15	1.29	1.69
Total regional fruit output ('000 tons)	1,711.2	3,959.2	944.9	7,976.0
Kernel yield at 7% of fruit ('000 tons)	119.8	277.1	66.1	558.3
Kernels marketed in 1980 ('000 tons)	73.0[a]	56.5[a]	20.5	183.5
Extraction rate (% of kernel yield marketed)	60.9%	11.1%	31.1%	32.9%

[a] Includes 50 percent of kernel production from município of Codó, Maranhão, which is divided between cerrado and cocais.

One factor which may determine the exploitation rate of extractive resources is population density. It has been shown above (Table 3.2), however, that the rural population density in the cocais is double that of the cerrado. Population density is thus inversely associated with babassu extraction rates in Maranhão. This is exactly the opposite of what would be expected should this be treated as a situation where population growth leads to increased pressure and eventual degradation of common property resources. Clearly there is something at work in the babassu zone beyond the pressure of increasing population on a fragile and scarce resource.

One possibility is that other resources enable cocais residents to rely less upon extractivism to support their basic requirements, and hence a smaller share of the resource base is exploited than in the cerrado. This hypothesis is the principal one adopted by those involved in efforts to improve babassu production, marketing infrastructure, and processing technology (Kono, 1976).

Another hypothesis, emerging from the geographical and historical conditions treated above, is that the babassu zone is experiencing what I have defined in Chapter II as a non-commons tragedy. People who have grown dependent for a part of their incomes on extraction of babassu products are being increasingly denied access to the palm forests on which they rely. The low extraction rates in the Cocais would thus be due more to impaired access than to efficient peasant resource allocation.

To explore the validity of either of these two alternative explanations, I conducted a comparative investigation of rural agricultural enterprises and the industries which utilize babassu palm products as raw materials in the babassu zone.

Research Techniques

To conduct this research, I was based at the State Institute of Babassu of Maranhão, in São Luis, the state capital (see Figure 3.4). While there was considerable interest in achieving broad geographical coverage and generalizability in the economic research expressed by my local collaborators, I was under no pressure to select specific field sites for in-depth survey research. After arriving in the babassu zone in early May, 1983, I spent two months interviewing knowledgeable people and exploring the interior at a reconnaissance level.

After completion of preliminary reconnaissance surveys and secondary data analysis, I selected three _municipios_,[8] each representing characteristics common to one of the three principal subregions of babassu occurrence in Maranhão. The selection procedure was adapted from those suggested by Collinson (1972) for definition of representative farms in

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[8] The Brazilian município is equivalent in some respects to the American county, but is governed by a mayor (_prefeito_) who is also responsible for administering the urban center of the município. There are 74 municípios within the area I have defined in this chapter as the babassu zone of Maranhão.

farm management research, and by Shaner et al. (1982) for establishing recommendation domains in cropping systems research. This procedure consisted of choosing the municipios that were closest to the subregional mean on a set of indices selected as important determinants of regional production conditions.[9] Those having most promising representativity scores were then screened for accessibility and local receptivity to the research. The three municipios selected were Chapadinha (cerrado), Lima Campos (cocais), and São Bento (baixada) (see Figure 3.4).

The next phase involved the selection of household clusters. Each of the three municipios was subjected to a reconnaissance study, with the aim of locating candidate home clusters or hamlets. This was done with guidance of local extension agents and leaders; the latter were then consistently included in the research. The aim was to include hamlets that exhibited the full range of tenure and internal organization that appeared common within each municipio. Selection was judgmental rather than random, and included attention to the problem of year-round accessibility.

Once the clusters were identified, a baseline survey was conducted with 219 resident households in 17 named hamlets in the three municipios. The survey focused on household composition, principal source of livelihood, assets, conditions of agricultural production, and utilization of babassu products for cash and subsistence. This survey served

[9] The procedure is detailed in Appendix A.

as the basis for selecting a random sample of households stratified according to a preliminary typology of tenure classes: small landowners, resident tenant farmers, occupants of untitled property, and estate administrators.[10]

Appropriate sample size was determined by measuring the variance over the population in the baseline survey of three variables: average annual crop area, household size, and dependency ratio. The data suggested that sample sizes of about 25 households in each municipio would be sufficient to characterize the population with a confidence level of 90 to 95 percent. This was also the maximum number of respondents I could reasonably expect my enumerators to visit each week, given the dispersion in the selected hamlets, and difficulties in gaining access to them during the rainy season.

The sample households numbered 74 at the initiation of the survey period in October, 1983. After three months, the sample was reduced to 48 households[11] in two municipios for logistical reasons;[12] the remainder of the project focused on

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10 The administrator and small landowner categories were combined in comparison of means analysis, as used in Chapter V.

11 During the progress of the survey, 20 percent of the initial sample households dropped out of the study in the cerrado because all or most of the household had departed from the region. An additional six records were dropped from tabulations presented in the study due to contradictions or incompleteness.

12 Besides financial considerations, the difficulties of monitoring data collection in three separate regions, each at least a four hour drive from my research base made it necessary to relinquish the weekly survey work in São Bento after three months. Nevertheless, the data and impressions obtained in the baixada sub-region provide an important contrast with that in the other two regions.

Chapadinha and Lima Campos in the cerrado and cocais sub-regions, respectively. The 48 remaining households each participated in a nine-month series of weekly interviews, carried out by enumerators employed and trained for this purpose.

The weekly interview focused on activity patterns of household members and budget information. Time spent in a number of different activity categories (on-farm agriculture, off-farm employment, livestock care, collection of forest products, processing, marketing, etc.) was tabulated for each active member (including children). Sources of income (both cash and subsistence consumption, the latter valued at local retail prices) and cash expenditures by category (food and household, production, clothing, etc.) were also tabulated weekly. Each household used a printed form for weekly recording of babassu-related production and sale, for kernels, oil, milk, charcoal, basketry, and leaves (for housing, feed, etc.) to improve accuracy of reporting of habitual activity. (Models of the survey instruments are included in Appendix A.)

All sample households were interviewed in detail at the outset of the survey to obtain further information on the prior year's agricultural production, use of credit, and current season's land preparation activities. During the progress of the research, I personally visited each field site a total of eight to 10 times to check that data were being collected uniformly and correctly. Some of the participating households became close friends, and provided information that complemented and extended the quantitative data. At the completion of the full rice production cycle in July, 1984, I conducted a retrospective interview with each household head to verify data tabulated on agricultural labor allocation, obtain estimates of crop output, and to ask about plans for the future.

All owners of properties within which sample households reside and a judgment sample of additional landowners in various parts of the babassu zone were interviewed in depth. The interview schedule focused first on the history of each property — its condition upon transfer, investments made and source of capital, and changes in relations between landowner and labor. Detailed information was obtained describing current enterprise characteristics, inputs, costs, and output levels. Each landowner was also asked to speculate on how the property would develop in the future, to provide a sense of his/her aspirations, and readiness to adapt to technological change.

Industry managers in both traditional oil processing and innovative fruit processing sectors were also interviewed in depth, in some cases through multiple interviews. These interviews focused on the current status of the firms, representing a range of scales and technologies. Information was obtained on process technology characteristics, raw material supply conditions and channels, markets, and other factors. Key problems of the babassu industry were explored in particular detail. A mail survey under the letterhead of my institutional sponsor was carried out, and I obtained a 50 percent return from operating concerns. Much of the data presented in Part Two of this dissertation were obtained from recent surveys of industrial firms conducted by staff of the Bank of Northeast Brazil (Salete, 1982) and economist Jair Amaral Filho (1983).

The research also involved collection and analysis of secondary data, as well as interviews with government and bank officials, capital equipment manufacturers, and merchants. Concurrent research on botanical and agronomic characteristics of babassu palms undertaken by my colleagues and sponsors greatly strengthened the technical details presented below.

Conclusion

This chapter has provided a detailed historical and geographic description of the study area. Also presented were the procedures used to select field research sites and carry out surveys at three different levels in the babassu production system: peasant, landowner and industry. Analysis of babassu extraction rates between the principal agro-ecological subregions in the babassu zone suggests that the impacts of agro-industrial change may differ geographically. While the region came under increasing pressure to absorb surplus Northeast population during the period 1950-1970, evidence suggests that the agricultural frontier no longer lies in the babassu zone. Different extraction rates are hypothesized to be due either to efficient producer resource allocation or to a non-commons tragedy arising from property rights exclusion.

To derive broadly applicable conclusions from the field research regarding the welfare implications of agrarian change, a diachronic perspective will fortify the "slice in time" that arises from the researcher's comparatively limited field experience. The next chapter presents a typology of agricultural enterprises. Based on examination of the processes of rural transformation, I trace progressive differentiation and articulation among enterprises in the Itapecuru Valley around Caxias, in the cerrado subregion of Maranhão. This provides a sense of the types of shifts to be anticipated in the babassu zone with the onset of agro-industrial change. These processes are traced further in Chapter VI in describing the progress of livestock ranching expansion, which has its greatest impact on the babassu economy of the cocais subregion. Chapter V links the two by comparative documentation of the link between small farm production and babassu extractivism among the cerrado and cocais families that were the subjects of detailed survey research.

CHAPTER IV

STRUCTURAL CHANGE IN BABASSU ZONE AGRICULTURE

Property rights affect the degree to which land resources are identified as exclusive in domain, and to whom the exclusions apply (Runge and Bromley, 1979). The prior distribution of property is critical to the outcome of agrarian change. Those who are included in the rights and responsibilities conferred by property stand to gain more than those excluded from access by shifts in technology or product value affecting the resources tied to the bundle of rights. Resource access limitations imposed by property rights do not simply emerge from legal tenure classifications, however. To assess the boundaries of landed property in agricultural systems, it is necessary to investigate how a particular form of production arose, how it reproduces itself, and what brings about its demise.

Some prominent social historians (e.g., Anderson, 1974; Dobb, 1963; Engels, 1972; Marx, 1964; Weber, 1976) have characterized societies according to their dominant method of organizing production. These organizational methods differ from each other most strikingly in the way property rights over land and men are defined. When dominant accepted property rights began to change, it was a signal to these analysts that the society as a whole was undergoing transformation. Neither property rights nor other societal characteristics are static; on the contrary, the social groups undergo constant internal differentiation. Individuals within one group or class may, in certain circumstances, form alliances with those in another, or even alter their group affiliation. Further, the direction of transformation is not necessarily predetermined by the nature of the antecedent organizational system. There may be a remarkable capacity for mutual reinforcement that allows more "advanced" systems to coexist with "traditional" ones, even after the dominant form has shifted (Rey, 1973).

Agricultural enterprises spanning a broad spectrum of organizational systems coexist in the babassu zone with varying measures of harmony. Using a descriptive typology, this chapter differentiates the principal types of agricultural enterprises in the region. Subsequently, it presents the key interrelations among different types of enterprises as they have evolved during the past two decades in a case study area in the cerrado subregion. The typology and historical case study have two purposes: first, to characterize the agricultural enterprises found in the babassu zone and, second, to predict which ones would be most likely to change their production methods so as to affect the babassu industry.

Toward a Structural Typology of Agricultural Enterprises

Several efforts have been made in the past to formulate typologies of rural producers in Northeast Brazil. Criteria used to formulate producer typologies are often biased by the purposes of data collection. For example, the Brazilian National Institute for Colonization and Land Tenure (INCRA) uses a legislatively-devised typology which affects differential treatment of rural properties under the land tax law, which INCRA administers.[1] Saint (1977), focusing on factors differentiating cassava, citrus, and tobacco producers in the Bahian Recôncavo, formulated a typology based on commodity specialization. Other indicators differentiating internal features of farm management, such as share of output marketed, proportion of usable land exploited (Kutcher and Scandizzo, 1981), principal source of labor (Bastos, 1980), size and tenure (IBGE, 1984a) have become standard in analyses of agrarian structure.

As a criterion to differentiate agricultural operations in Northeast Brazil, farm area alone is insufficient, since agro-ecological conditions such as soil fertility, moisture, and relief differ significantly between properties of similar size (Andrade, 1973). The same-sized properties may also exhibit radically different production organization. Previous research on Northeast Brazilian agriculture has opted instead for classifications along a continuum of production organization and social relations that researchers derived from

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[1] Law number 6,746, dated December, 1979, an amendment to the rural land law known as the Estatuto da Terra, aimed to tax unproductive enterprises at a higher rate, so as to redress rigidity in tenure patterns. Rural enterprises were to be taxed at progressively higher levels commensurate with their size and proportion of land area unutilized for production. The law has not brought about the promised loosening-up in rural land markets, primarily because it is not enforced and high rates of evasion occur. However, the legislated cadastral scheme does provide a statistical base for differentiating enterprises according to their internal production characteristics.

reviewing the history of agrarian transformation in the region. In particular, the progressive differentiation among firms which show evidence or lack of "capitalist" behavior patterns (e.g., capital accumulation, wage labor, production principally for market) has formed the backbone of analyses of agrarian structure. Such an analysis provides evidence of the direction of the transformation underway, as well as of the resistance and functionality of enterprises considered "noncapitalist" to broader societal change.

The present study does not accept the simplification imposed by differentiating agricultural enterprises only along the broad categories of "capitalist" and "noncapitalist". A large body of debate in development theory has focused on the fallacies of treating economic systems as either dual or homogeneous in respect to their underlying "laws of motion" or driving principle (see Foster-Carter, 1978 for a review). It is beyond the province of this study to delve further into this debate. Suffice it to say, nevertheless, that while rural productive enterprises in the babassu zone may well exhibit characteristics generally ascribed to noncapitalist economic systems, such enterprises now interact through markets with a broader society that is most definitely capitalist in structure and economic logic. Moreover, to describe the range of enterprise types as either "capitalist" or "noncapitalist," is not enough to enable us to determine why babassu may be important economically to some enterprises and irrelevant to others. To suggest that noncapitalist enterprises will be inexorably supplanted by capitalist ones provides no grounds for ascertaining the pace of their transformation, nor their internal resilience to withstand change.

To devise a typology adequate to describe the structural variants I observed in the field, survey data are here combined with census and cadastral figures measuring the relative share of land and enterprises within classes. To differentiate these enterprises, they are described below with respect to: (1) who "controls" the land; (2) principal source of rents and stage of technology; (3) source of variable capital; (4) method of labor recruitment; (5) method of administration; and finally, (6) degree of market integration. The characteristics of the principal categories of enterprises identified in the babassu zone along these criteria are summarized in Table 4.1. Because these criteria are not in all cases directly correlated with those used by statistical agencies in Brazil, estimates of current land coverage and number of enterprises within each category are inexact but sufficient for predictive purposes.

Enterprise Types in the Babassu Zone

The babassu zone, as described in the previous chapter, was dominated after colonization by estates operating along the lines of slave plantations. Their legacy today exists in the form of properties which were either divided from the

Table 4.1. Typology of agricultural enterprises in the babassu zone.

CRITERION/TYPE	LATIFUNDIA BY DIMENSION	LATIFUNDIA BY EXPLOITATION	AGRIBUSINESS ENTERPRISES
LAND CONTROL	Merchant/agro-industrialist	Petty mercantilist	Investment group
SOURCE OF REVENUES	In-kind rental; agro-industrial products	In-kind rental; own production; cottage industry	Domest. mkt. (mostly cattle)
SOURCE OF VARIABLE CAPITAL	Bank credit; barter exchange	Barter exchange; sale of beef	Government subsidized credit
LABOR RECRUITMENT	Resident households	Resident households	Perm. and seasonal wage workers
ADMINISTRATION METHOD	Administrator/ storekeeper	Owner-administered	Professional manager
MARKET INTEGRATION	Weak	Weak	Strong
APPROXIMATE NUMBER IN BABASSU ZONE	+/-20[a]	cerrado: 50%[b] cocais: 25%[b]	> 100 in region[c]
APPROXIMATE AREA COVERED	> 50,000 ha. (each)	cerrado: > 90%[b] avg. = 615 ha. cocais: <70%[b] avg. = 420 ha.	> 1.5 million ha. avg.= 11,500[c]

Footnotes are at end of table on the next page.

Table 4.1. Typology of agricultural enterprises in the babassu zone, continued.

CRITERIA/TYPE	MEDIUM-SIZED FARMS	MINIFUNDIA & SQUATTERS	LANDLESS AND NEAR-LANDLESS
LAND CONTROL	Farm families; local retailers	Farm families	Latifundia; state govt.; farm families
RENT SOURCES	Marketing produce (milk, beef, rice)	Marketing of surplus rice & babassu kernel	Rents paid, seldom gained
SOURCE OF VARIABLE CAPITAL	Local bank credit; product revenues	Product revenues; local bank/merchant credit	Landowner advances on rent; babassu kernel sales
LABOR RECRUITMENT	Salaried herdsmen; daily wage workers	Farm household; daily wage workers at peaks	Farm household; labor-sharing
ADMINISTRATION METHOD	Owner or manager-administered	Owner-administered	Producer, on landowner's authority
MARKET INTEGRATION	Strong	Weak	Weak
APPROXIMATE NUMBER	cerrado: 2%[b] cocais: 4%[b]	cerrado: < 50%[b] cocais: < 75%[b]	> 90% of producers in the region[a]
AREA COVERED	cerrado: <2%[b] avg. = 275 ha. cocais: > 7%[b] avg. = 270 ha.	cerrado: < 8%[b] avg. = 54 ha. cocais: < 16%[b] avg. = 35 ha.	850,000 ha.[a] state lands; remainder on private prop.

[a] Based on figures in 1980 agricultural census (IBGE, 1984a). According to the census, there were approximately 325,000 landless or near-landless producers in the babassu zone.

[b] Based on proportion of land in INCRA (1974) categories for Alto Munim (cerrado) and Mearim (cocais) microregions.

[c] Based on federally-subsidized agro-pastoral projects in Maranhão, most lying in the babassu zone (see Chapter VI).

original estates by heirs or tenants and continued as large *latifundia*, or, more rarely, were left in the hands of former slaves and their descendants, who occupied these lands as collective property. Other forms of property occupy the interstices between these former estates, and the heretofore unoccupied frontier. In the order of their description below, these include: (1) agribusiness enterprises, (2) modernizing medium-sized farms, (3) *minifundia* (small owner-occupied farms linked economically with latifundia and other large agricultural operations as sources of labor and food crops) and finally (4) landless or near-landless renters, squatters, and sharecroppers.[2]

Persistent Latifundia

There are two types of latifundia in the classification scheme employed by INCRA. Those described as latifundia due to their prodigious size are termed "latifundia by dimension." Those which are categorized as latifundia due to their internal production organization rather than size alone are termed "latifundia by exploitation." Both types may be considered remnants of colonial forms of property, collectively exhibiting low rates of land utilization and continuity in paternalistic landowner-resident labor relations.

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[2] The terminology to describe different organizational forms are derived, for titled properties, from the INCRA typology (*sensu* INCRA, 1974) classified in accordance with the Estatuto da Terra. Landless operators of agricultural enterprises are described within categories used in the national agricultural census (*sensu* IBGE, 1984a).

The latifundia by dimension (LD) in the babassu zone are controlled by families of local origin with links to merchant and agro-industrial capital whose rural lands and tenants constitute their political and economic powerbase. Latifundia by exploitation (LE), often controlled by lower-ranking members of the LD latifundia-owners[1] family or associates, tend to occupy a smaller contiguous area, while LD properties often consist of scattered large land units accumulated as investments over time. The latter may more properly be conceived of as clusters of rural communities occupying land under a single ownership.

Rents for both forms of latifundia are derived from shares or, more common today, fixed rent in kind for land used in shifting cultivation by rentier peasants (moradores) who reside on the property. Owners of LD properties derive additional rents from value-added via agro-industrial processing of raw materials, chiefly rice, wood, and babassu kernels from their own and others' lands. The size of their properties and the range and quantity of goods produced on the LD estates by the internal labor force provides the fundamental distinction between them and the smaller owner-operated LE properties.

In the case of most LD estates, the patrão is absentee, with residence in the state capital or even outside of the region altogether. One or more administrators are hired or commissioned to keep an eye on things; they are entitled to run a store (quitanda) where goods are traded. Profits are thus also obtained through barter[3] of food and some industrial commodities for babassu kernels and other products of the moradores. The administrator obtains either a share of the proceeds or a salary, and frequently also obtains the right to graze animals and plant crops on the property. On the LE properties, on the other hand, the patrão is commonly resident on the property (though he is likely to have a home in the municipal seat), grows his own crops with labor hired-in from among the moradores, herds animals, and runs his own store. Agricultural technology is seldom more advanced than that employed by the "internal" labor force of moradores, although LE proprietors plant an average of about 15 ha. annually, far more than the moradores (Table 4.2). Under these conditions, the degree of market integration is slight; only the surplus rice, the babassu kernel output, and an occasional head of cattle are marketed off the property by the landowner to finance his consumption.

Rudimentary processing of agricultural and extractive commodities is done on the LE properties (e.g., production of cassava meal or *farinha*, distilling of cane alcohol, sawmilling). These products are also mostly for internal requirements. In contrast, LD property-owners, as a result of the

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[3] Barter here refers to exchange of goods at their local market value, i.e., there is a presumed conversion to a currency equivalent in order to determine a value basis for exchange. A profit is made on both the resale of the goods received in barter and the margin over purchase cost on items for which landowners and storekeepers exchange the bartered goods.

Table 4.2. Assets of producers surveyed in Lima Campos and Chapadinha, Maranhão, by farm type.

TYPE/VARIABLE	MEDIAN PROPERTY SIZE (ha.)	AVERAGE ANNUAL CROP AREA (ha.)[a]	SIZE OF CATTLE HERD (head)
Latifundia (LD & LE types) n = 9	1,000	14.6	133
Agribusiness projects n = 1	2,500	200	1,000
Medium-sized farms n = 10	500	16.4	314
Minifundia n = 17	52	2.4[b]	14[b]
Squatters[c] n = 26	0	2.1	0.24
Moradores n = 101	0	1.6[b]	0.17[b]

[a] Farm family crops only (does not include moradores' areas).

[b] Minifundia and moradores are equally weighted for average crop area and herd size between cocais and cerrado properties.

[c] All squatters are located in cocais survey areas.

sheer scale of their estates and the ability to employ more workers in non-agricultural activities, generate sufficient surplus to venture into urban-based agro-industry. Historically this involved a progression of enterprises from cotton ginning to textiles, rice milling, babassu oil expelling and soap manufacture. The maintenance of highly diversified income from agricultural, mercantile and manufacturing sources provided these families with stability and a buffer against the vagaries of the market. Combined with the political power of the landed aristocracy, this diversification explains the persistence of the latifundia (de Janvry, 1981; Bastos, 1980).

Geographically, latifundia are greater in number and area occupied in the cerrado region. LE properties occupied more than 90 percent of the titled land in a representative micro-region of the cerrado[4] in 1972, while they occupied about two-thirds of a representative microregion in the cocais, according to INCRA statistics (INCRA, 1974). They are also more numerous in the cerrado than the cocais (nearly half versus less than one-quarter of titled properties, respectively). The survey latifundia had a median size of 1,000 ha., but ranged from 160 to over 15,000 ha. (Table 4.2). If units over 10,000 ha. in size are regarded as LD properties, the agricultural census registers six such properties in the Alto Munim microregion in 1980, and only one in the Mearim (IBGE, 1984a). Despite their deceivingly small number, LD estates constitute a significant proportion of the agricultural land in the cerrado; when smaller properties are tabulated for multiple property registration, the concentration of its control is notable.[5] This reflects the tendency for LD estate

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[4] The two homogeneous micro-regions selected for comparison are the same as those wherein the survey properties lie: Alto Munim in the cerrado, and Mearim in the cocais.

[5] LD properties registered in the babassu zone of Maranhão averaged over 50,000 ha. apiece in 1972, according to INCRA definitions (INCRA, 1974); these were single contiguous

owners to accumulate scattered properties rather than amass contiguous holdings.

In summary, latifundia continue to comprise the most important production enterprises in the babassu zone in respect to area occupied and resident laborforce. Their importance in these terms is greater in the cerrado than in the cocais sub-region. As most babassu production is extracted in the cerrado (Table 3.8.) the latifundia of this region are hence important enterprises to consider when contemplating alterations in babassu-related land use and technology.

Modern Agribusinesses and Medium-sized Family Farms

The difference in proportional importance between cerrado and cocais latifundia is explained by the larger area covered and numerical advantage of both small and medium family farms and modern agribusiness operations in the Cocais. Settlement in the cocais is more recent, biased toward smaller farmers from within the region and from other Northeast states, who have either been able to muster sufficient capital to purchase segments of older estates or obtain legal title after years of occupation as squatters. At the same time, the fertile

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estates, not tabulated for multiple property registration in the same household or extended family. In property registration studies using 1965 cadastral data conducted for analysis of agrarian structure in the municipios of Caxias and Aldeias Altas, Maranhão, William Nicholls (unpublished data) found that 60 individual owners had title to 106 properties, giving each of them combined holdings over 2,000 ha. In addition, 54 extended families had combined title to over 2,000 ha; 13 of these controlled over 10,000 ha. among family members.

western valleys of Maranhão have become a focus of agro-pastoral project investment benefiting from federal government subsidies since the late 1960s. The latter are largely cattle ranches on improved pastures comprised of lands assembled by external investment groups and in some cases wealthy and politically powerful regional families. In this section, I first describe the modern agribusinesses and then the medium-sized family farms.

While the amount of land they occupy makes modern agribusinesses appear similar to the latifundia, an important difference between them is that, rather than being based on "internal labor" supplied by moradores, labor recruitment in agribusiness enterprises takes the form of permanent or seasonal wage employment. Due to the highly capital-intensive nature of modernized cattle ranches, unskilled labor utilization is not significant except for sporadic pasture maintenance and fencing jobs. Typically, the only resident employees are livestock herders and managers. The professional technicians who manage these enterprises are often responsible to a parent firm headquartered in other Northeastern states, Brasilia, or the Southeast metropolis. The parent firm exercises control over financial dealings, political maneuvers (including legitimation of property control), and marketing, leaving the day-to-day running of the farm to the resident employees. There have been over one hundred such projects established on over 1.5 million ha. in Maranhao since the late 1960s, most in the cocais and Pre-Amazonic regions. These operations average 11,500 ha. in size. Their expansion has been viewed as a principal reason for visible diminution in babassu stands and for pressures on the peasantry for land (Anderson & Anderson, 1983; Wagner, 1981a).[6]

At the same time, in parts of the cerrado sub-region surrounding the municipio of Caxias near the eastern border with the state of Piaui, investors have established two major sugarcane, reforestation and agro-industrial operations oriented toward sugar, ethanol, and cellulose manufacture. Similar in enterprise organization to the modern ranching operations at the Amazon frontier, but considerably larger in scale, these new product enterprises are also engaged in land use substitution, with parallel effects on labor and access to land resources for the peasantry. The environment in which these latter firms evolved, and the types of effects they have engendered, are explored in depth in the second part of the present chapter.

In the mid-range between the agribusiness firms and the small family farms lies a class of medium-sized farms, modernizing in technology. These are primarily dairy and beef cattle operations on planted pasture, increasingly including a mechanized crop production component. Such farms are typically owned by immigrants from other states or by local service and retail tradesmen whose savings and ability to mobilize credit are focused on productive investment in agricultural

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[6] See Chapter VI for a detailed discussion of the growth in government subsidized ranching activities in the babassu zone.

land. These farmers finance much of their variable costs from agricultural product marketing, and hence the majority of the farms' output enters regional market channels. Babassu kernel sales are of declining importance as is the incorporation of moradores as a principal means of labor recruitment, with movement toward greater use of day labor from nonresident workers. These farms are administered by a resident landowner or full-time employee who is also an equipment operator.

Medium-sized farms of this type are most common in the cocais sub-region and its fringes, constituting over seven percent of the land area in titled farm properties in the Mearim microregion in 1972 at an average size of about 270 ha.[7] However, these units have grown in size by consolidation; survey properties in this category had a median size of 500 ha.

In summary, agricultural modernization in the babassu zone has taken the form of two distinct enterprise types. Agribusiness operations have been dynamic in occupying new lands for rapid conversion to improved pastures, sugarcane and tree plantations. Their dynamism is partially explained by government credit policies which have favored agro-industrial development rather than land distribution as a means of enhancing agricultural output. However, there has been a parallel development in the babassu zone of family farms of

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[7] These figures constitute estimates based on the INCRA category of "<u>empresas rurais</u>." There were few agribusiness operations in existence during the cadastral survey in 1972; thus it is estimated that the empresas rurais registered at this time may be taken to represent medium-sized family farms.

moderate size oriented toward production of foodstuffs for urban markets. In both cases, the use of resident labor has been considerably reduced, and there has been a decline in the importance of receipts from babassu extractivism to the overall operation.

Minifundia and "Secure" Squatters

At the bottom of the size scale of registered properties are small farm operations of either titled landowners (minifundia) or squatters who have gained entry into the maze of juridical procedures necessary to secure title. While the tenure categories of these two groups are formally treated separately, the squatter, if fortunate, will ultimately attain full legal title to the land his household occupies. The prospect of attaining title is legitimized by law,[8] but in practice it is exceptional due to bureaucratic delay and political intransigence.

The small farmer universally produces subsistence and some market goods under shifting cultivation; he may own a modest herd of cattle (survey minifundia owned an average of 14 head[9]) as well as other livestock. He may also operate a

[8] The Brazilian Land Statute, Law number 4504 of November, 1964, sets the legal framework for titling of unclaimed lands, enabling occupants to petition for title after five years of productive use.

[9] Ownership of cattle was substantially more pronounced among minifundia of the cocais, where small landowners often pay pasturage fees to ranchers instead of converting land to pasture.

small goods store and run a cassava roasting cottage industry. Capital for variable inputs is, in good times, derived from profits from agricultural production and from credit; in a bad year, livestock is marketed, produce is sold at or even prior to harvest to creditors, and there may be more reliance than usual on babassu collection or resale. Small farmers make intensive use of family labor, but may also house moradores on their property to assist the family at weeding and harvest time; when the crop is good and savings or credit suffice, daily labor is hired-in. Administration is by the head of the small farm household.

Small farms of this type are numerous throughout the babassu zone, comprising nearly three-quarters of all properties in the Mearim micro-region and nearly half in the Upper Munim in 1972, yet they control very little of total registered land (see Table 4.1.)• Average farm size was 35 ha. among minifundia in the Mearim and 54 ha. in the Upper Munim in the same year. By necessity, such small farmers are dependent upon the local latifundia-owners, urban merchants, and bankers to secure credit and production inputs. Because they depend upon elites and consume a large share of their own output, minifundia are often agglomerated with tenants and sharecroppers as part and parcel of the "peasantry" (Bastos, 1980). However, the titled owner of the median 52 ha. minifundio in my sample is somewhat better off than the vast majority of landless moradores and squatters interviewed for this research (Table 4.2.), though minifundio operators were found who fit the characteristics of the peasantry.[10] It was thus seen necessary to differentiate beyond the criteria applied in previous studies to identify those most vulnerable to changes in rural conditions.

One measure which may be used as a cutoff is that of the minimum production "module" which is defined as the land area within a specific agro-ecological zone which is the minimum required to enable an average-sized household to sustain itself from agriculture. Below this level, the producer would be forced to rely upon off-farm employment and rented land for agriculture to meet subsistence needs.

With the annual average crop area of 2.4 ha. found among minifundio-owners in the survey, about 17 ha. are needed to fulfill an average crop-fallow cycle of 7 years under shifting cultivation. If only two-thirds of the minifundio contains arable cropland, the producer who owns 25 ha. would just squeak by. However, it has been shown that, in many areas of the Northeast of Brazil, minifundia lie on lands marginal for crop production (Paiva, 1979). Furthermore, babassu extractivism requires considerably larger areas for the average peasant household, necessitating access to others[1] property.

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[10] The distinction between landowner and landless, no matter how miniscule the property, goes well beyond tenure security itself. Those with some land are more easily able to obtain credit, as they have secure collateral, rather than having to rely on a landowner's largesse in signing a letter confirming land allotment. In general, it is these better-off among the peasantry who provide most of their own consumption from agricultural production with lesser importance of off-farm work or extractivism, as will be shown in Chapter V.

Although identification of a single modular farm size for an area possessing as much agro-ecological variation as the babassu zone may be questioned, it provides a basis for determining what may be called "near-landlessness" (Esman, 1979; Lassen, 1979) or for identifying farmers who are "semi-proletarian" (de Janvry, 1981). For this study, farmers who occupy land units less than 25 ha. in size under secure tenures are treated as "near-landless" peasants.

Landless and Near-Landless Peasants

By definition, the landless and near-landless, comprising the categories of landowners under 25 ha., moradores on latifundia under fixed rental or sharecropping arrangements, and squatters produce some or all of their crops on lands of others. Their incomes are derived from goods they produce or gather for sale or consumption, and from which rents are extracted by landowners or merchants, as well as from frequent off-farm employment, when the opportunity presents itself. Production technology in use by these farmers is overwhelmingly primitive, involving use of few inputs other than labor, seed saved from the prior harvest, and some insecticides. Credit needed to maintain the household and cover the cost of the few variable inputs is frequently linked to marketing agreements with a patrão or local storekeeper. Moradores are rarely able to mobilize bank credit, though production loans for tenants are provisionally available under the landowner's signature confirming land allotment. Labor is recruited from within the household and exchanged with other landless families on an equivalent basis ("troca de dias"). Land is allocated to tenants by landowners or administrators on the basis of a verbal contract providing for the tenant's responsibility for the plot over a cropping cycle. In practice, these preconditions assure that the amount of land cultivated by most such families is very limited. However, most of the agricultural production in the region is accounted for by the landless and near-landless (see Table 5.1).

Although not always a part of contractual arrangements, morador residency entitles the household to extractive resources contained in secondary forests on the property, on the condition that marketable products are sold through the landowner or his agent. Squatters and moradores are entitled by customary property rights to fallow resources, they manage as "dono da roça" or last cultivator. They then have an incentive to retain useful trees, particularly palms, on the site when clearing for shifting cultivation. However, their insecurity of tenure does not ensure them of benefits from fallow resource management. Nearly half of the families I interviewed in the cerrado survey areas in 1983 had resided on the properties for less than five years.

Owners of properties under 25 ha., moradores, and insecure occupants of public or privately owned land, some of whom are roadside or urban fringe dwellers, constitute the vast majority of rural producers in the babassu region. In 1980 the babassu zone, consisting of 74 municipios in seven homogeneous microregions in Maranhão, was reported to contain a total of 361,373 agricultural enterprises, of which at least 90 percent fit into the category of landless or near-landless as defined here (IBGE, 1984a).

Dynamics of Agrarian Transformation - The Case of Caxias

To assess the future of the babassu industry and the peasant farming systems with which palm product extraction is currently linked requires an understanding of the pace and direction of agrarian transformation. Which of the enterprise types described in the previous section are most likely to increase in relative share, and which will decline? How will this affect the status of the peasantry? These questions demand that we consider the dynamics of change in the babassu zone to identify the factors that have heretofore been critical to change. The analysis of change dynamics begins with the hypothesis that those enterprises most able to mobilize capital and to delimit exclusive rights and uses to property might be those most successful in achieving dominance in the future. On the other hand, there may be areas where the entrenched political interests of a traditional oligarchy combined with relatively infertile land may bring continuity.

The latifundia represent critical enterprises for study. Latifundia occupy the lion's share of land and provide residence and employment for the majority of the region's landless farmers. Their production relations are paternalistic; their diversified enterprises and negligible interchange with market economies makes them resistant to change. Rigidity of tenure patterns and landowner-morador interdependence have characterized latifundia dominance in the region.

Whither the Latifundia of the Babassu Zone?

To begin the study of changes underway in the babassu zone, I now describe alterations over the past 20 years among farms, predominantly latifundia, located in the Itapecuru Valley, one of the longest settled parts of the cerrado sub-region. Historically, this area had been the center of the region's cotton industry, which entered into decline during the early Twentieth Century. Despite its entrenched political-economic power base, its historical resilience to withstand external change over three centuries, and rigidity of land control, Caxias, one of the last strongholds of the old guard, has experienced dramatic shifts. The changes experienced among latifundia of Caxias offer a perspective on the response to current macroeconomic forces in the regional and national economy. However, the specific pattern of change, and its implications for the babassu industry differ with those of the cocais, which are to be described more fully in Chapter VII.

The account which follows draws heavily on the work of my predecessors in describing the character of Caxias agriculture. The late William H. Nicholls, an American economist, and Ruy Miller Paiva, a renowned Brazilian agricultural economist, arrived for the first time in Caxias at the end of the 1962-63 harvest season. During their survey, they visited 10 operators whose enterprises evidenced a range of scales and property types found in the Itapecuru Valley in that period. Nicholls analyzed these data as part of a broader project on the structure and productivity of Brazilian agriculture, involving visits to 99 farms in seven important food producing regions (Nicholls and Paiva, 1966).[11]

Ten years later, they were back. Nicholls and Paiva aimed on the follow-up visit to seek out the same landowners and small farmers they had interviewed ten years before, in order to determine what changes had taken place in their enterprises and the way they managed them.[12] On several occasions during 1983 and 1984, I visited Caxias, one of the largest municipios by area, and historically the largest babassu-producing municipio in Maranhão. I was able to locate and conduct detailed interviews with three of the original

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[11] Throughout the remainder of this chapter, the acronym N&P will be used in reference to the study by Nicholls and Paiva (1966) describing the Caxias area as it appeared during their 1963 visit. Although the size of their sample was insufficient to generalize to the babassu zone as a whole, or even to Caxias itself, their research offers a perspective on the way in which agricultural systems have evolved that is unique and valuable.

[12] Although the collaborators were able to complete analyses of changes in the fazendas of Southern Brazil they revisited (Nicholls and Paiva, 1979), Nicholls died before the Northeastern data could be compiled and transmitted to Brazil for publication. Nevertheless, it was possible to obtain the raw data in the form it was collected in the field, and to discuss with Paiva the approach taken in the interviews and selection of farms in Caxias. I was also able to obtain the preliminary working tables Nicholls prepared on the farms revisited from his widow, who had accompanied him on further follow-up visits to the Northeast farms just before his death in 1979.

landowners in the N&P survey as well as to obtain information from two new owners and other knowledgeable local people regarding the fate of the other farms visited in 1963 and 1973.[13] The data on these farms is presented here as part of a descriptive and analytical basis for predicting change in the babassu zone.

Changes in Property and Land Use from 1963-73

The 10 enterprises that comprised N&P's original judgment sample in Caxias included three distinct groups, which may be categorized within the typology above as latifundia (both LD and LE types), medium-sized farms, and landless producers, both squatters and moradores. The six latifundia, besides the landowners' agricultural, livestock and processing operations, incorporate what N&P described as a "permanent workforce" of 440 moradores, 14 administrators, and 17 herders, each of whom carried out their own individual agricultural, livestock husbandry, and babassu-related activities on the properties. In view of their sole proprietorship and the landowner's obvious intervention in decision making by the resident laborforce, N&P rightfully treated the latifundia as individual enterprises.

The Caxias farms N&P visited in 1963 ranged in declared property size from 160 to 5,990 ha., with a median of 1,000

[13] In relocating the farms and tracing changes in production systems and ownership, I obtained assistance from local extension and agricultural mechanization service personnel.

ha., equivalent to that I discovered in my wider-ranging surveys in 1983 (Table 4.2.)• The 1960 agricultural census for Caxias enumerated 528 titled properties on total land owned in this category of over 410,000 ha., for an average unit size of 781 ha. (IBGE, 1964).[14] In the same year, the census registered nearly 7,000 landless renters on private properties and squatters on untitled public land whose agricultural activities occupied only 13.4 percent of all land in agriculture.[15] However, because the land they occupy is incorporated within that of landowners, renters do not legally control land they cultivate in Caxias. Hence, of the total land in farms in 1960, that under the legal control of owners of latifundia and minifundia constituted 87.7 percent, of which the vast majority was held within properties over 500 ha. in size. State lands held insecurely by squatters comprised the remaining 12.3 percent (Figure 4.1).

The principal change in agricultural property characteristics in Caxias between the 1960 and 1980 census was a near-

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[14] This study relies on data from the agricultural census as the best available estimate of overall conditions of agricultural production in the municipio of Caxias as a whole.

[15] N&P note that the nearly universal technology for agricultural production, slash and burn shifting cultivation, requires an average of at least five years of fallow in this region. Producers would hence require an area about six times as large as their current "land in crops" to sustain their enterprises. N&P include the full six year cycle in their cropland estimates. Usufruct by peasants to cropland over an entire six-year cycle is not guaranteed, however. Squatters and renters in Maranhão are hence mobile, constantly seeking new lands, often in other municipios. In rare cases they are able to obtain title to the land through the law of usucapião, which, after 1964 provided that producers who could prove occupancy for over five years had the right to title.

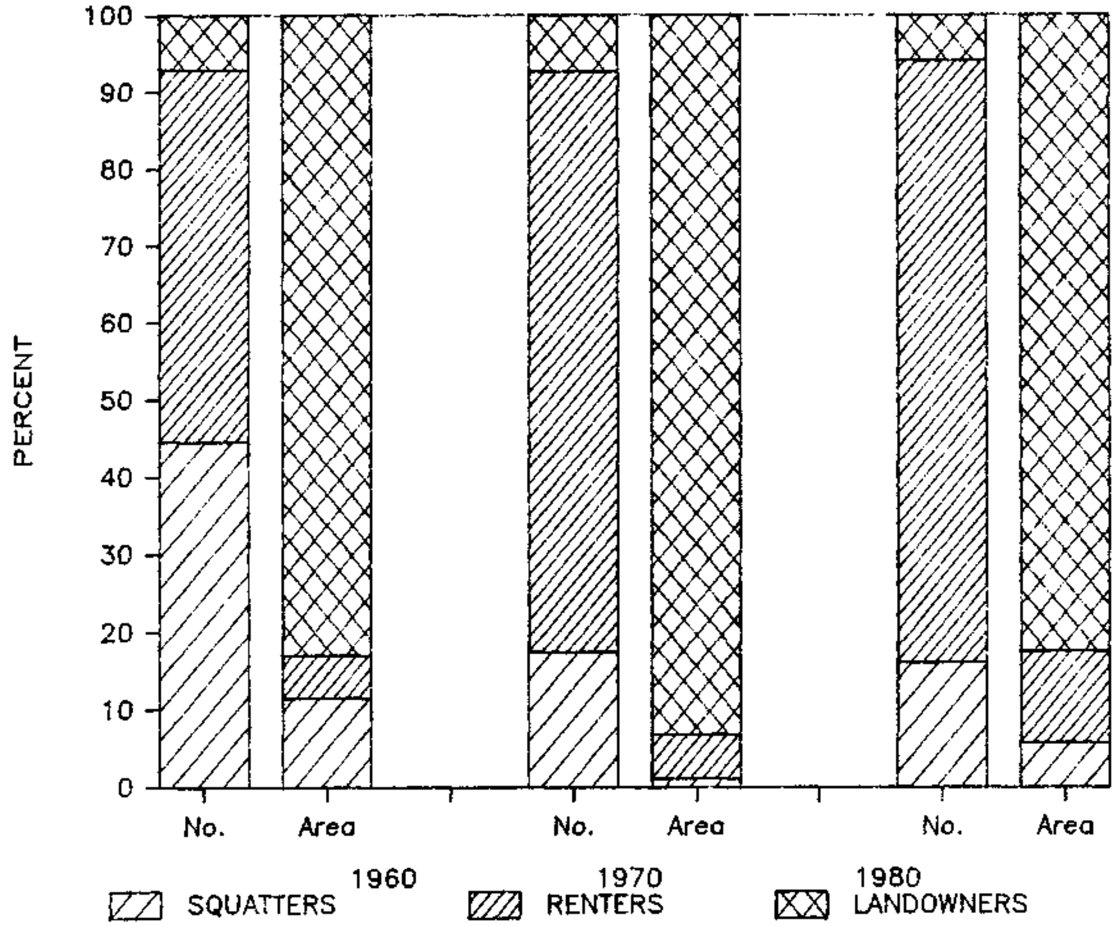

Figure 4.1. Area and number of agricultural establishments, by tenure category, Caxias, Maranhão: 1960 - 1980 (IBGE, 1964; 1974; 1984a).

halving in the proportion of agricultural land in squatters' hands (from 12.3 to 6.6 percent) and an even steeper decline in the proportion of producers categorized as squatters (from 43.6 to 16.3 percent; Figure 4.1).[16] Where did the squatters go? Some clearly became titled property-owners, as the number of such properties nearly doubled from 1960-1980 in Caxias, with a concurrent reduction of nearly two-thirds in average property size. One of the properties included in the 1973 survey by Nicholls and Paiva was that of an immigrant from Ceará who had been able to secure title to state lands he occupied in Caxias.

Other families who once produced on state lands moved into the category of moradores. As the lands on which they produced were titled by others, they often stayed on the property or were forced to seek an estate where they could reside as renters. The number of producers in the category of renters nearly quadrupled between the 1960 and 1980 censuses, from a combination of successful titling by squatters, in-migration of new renters, and natural population growth.[17]

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[16] In the 1950 census, squatters represented nearly three-quarters of all producers in Caxias. Despite the great decline in the proportion of producers in this category between 1960 and 1980, squatters decreased in number by less than 25 percent. In fact, the 1980 census shows a considerably larger land area than that in previous years under squatter operation, resulting in a tripling in average unit size. At this level of aggregation, the ratios are more reliable than absolute numerical figures.

[17] Nicholls and Paiva (unpublished data) registered an increase of nearly 50 percent in the number of resident households on six identical properties surveyed between 1963 and 1973. At the same time, however, the amount of land per resident household had declined less than 10 percent, due to

N&P devote considerable attention to the relationship between agrarian structure and producers' material conditions, as their initial surveys were accomplished in the context of social upheaval. Had the military not clamped-down on social movements in 1964, political expediency could have forged a land reform in the Northeast in response to pressures from both peasant leagues and urban consumers. The N&P studies were apparently undertaken with a view toward questioning the validity of land reform, if not serving as an apology of the existing order. In their view, participation by landless in the latifundia system

> may represent a rational 'preference' on the part of the allegedly 'exploited' moradores. . . . the reason [that they and nearby squatters are poor] may be far more because of the particular combination of economic resources and primitive technology at their command than because of the prevailing agrarian structure. . . If the large landowner has any monopsony power in Caxias, it is primarily in his capacity as a commercial buyer of farm products, since moradores on his land are obligated to sell to him unless they wish to pay a fixed rent (foro) in kind instead. . . The existence of the real alternatives of paying a known foro or of migrating to State lands certainly do establish certain limits to the morador's commercial exploitation by the landowner. [N&P: 25-26; underlining in original]

Squatting as a "real alternative" to land rental mentioned by N&P has been progressively foreclosed in Caxias, so that the availability of "nearby State land" as a settlement option is

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an increment in property size. Nicholls notes in his analysis of the 1973 data (unpublished manuscript) that all the new land stock was made up of poor quality woodland for grazing, not cropland. Hence the incremental resident worker households would mean some decline in land usable for shifting cultivation. This is reflected in a decrease in actual cropland allocated to resident households of 36 percent per household.

no longer valid. Instead, over the past decades, migrants from older settlement areas in the cerrado of Maranhão as well as other Northeast states have increased the resident population on private estates rapidly while pushing forward the Amazonian frontier of the babassu zone.[18] By N&P's own logic, as the squatting option is foreclosed, moradores would become more vulnerable to latifundia monopsony. However, peasant welfare in Caxias apparently has not been seriously eroded by landowners' commercial interests, because improvements in market infrastructure rediced landowners' monopsony power. Instead, landowners have derived increased rents from in-kind payments, and have benefited from the growth in demand for babassu kernel, which was supplied by a resident labor-force increasingly pressed for arable land.

Labor or **Capital Investment for Caxias Agriculture?**

The wealth generated by latifundia of Caxias up to the early 1960s had been largely derived through commercialization of peasant production. By the late 1960s, cropland rental arrangements that required peasants to market their surplus through the landowner had given way to increased use of in-kind rents. One of the reasons for this shift was the opening of transport routes, which made it possible for peasant producers to sell into local markets. In order to sustain the return from the rentier system, landowners

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[18] The process of frontier expansion will be described in Chapter VII.

gradually increased the fixed rental payment. From the early 1970s to the 1980s, these rents doubled from approximately 106 kg. of unhulled rice to 211 kg. per ha. cultivated. This represented an increase from less than 10 percent to nearly 20 percent of average regional rice yields that usually average slightly over 1,000 kg. per ha. under traditional intercropping in the cerrado.[19] Moreover, moradores were still required to sell babassu kernels through the landowner, who obtained up to 50 percent of the urban market price. Commodities exchanged for babassu kernels in estate stores also generated a profit for proprietors, as did informal credit extended to moradores.

While the agrarian structure had undergone some subtle modification since the first N&P survey of Caxias, there was little, either in the 1970 census or in the data on the farms revisited in 1973, to indicate major changes in predominant on-farm land use or technology. To be sure, the data show cases of individual advances as well as of declines. Overall, the proportion of agricultural land in crops and planted pasture in Caxias remained at about 12 percent and 15 percent, respectively, over all four agricultural censuses between 1960 and 1980. The follow-up visits by Nicholls and Paiva echo the

[19] It should be noted that these rents were still considerably less than those exacted by landowners in the semi-arid Northeast, where sharecroppers pay up to 50 percent of their crop for the right to till the soil (Scandizzo, 1979). Under a pure rental rather than sharecropping agreement, however, it should be noted that the landowner has no incentive to invest in crop productivity, so absolute yields may be considerably lower, and the return to producers much less (Cheung, 1969).

overall stability in agricultural land use in Caxias between 1963 and 1973.[20]

The Caxias farms emerge in the 1973 data gathered by Nicholls and Paiva as somehow insulated from changes similar to those they found evident by this point in Brazilian agriculture overall. It was the only one out of seven survey areas where labor use on the properties visited for the second time had apparently <u>increased</u>. While they report an increase of nine percent in the number of permanent resident families per unit land in Caxias, Nicholls and Paiva (1979) found a <u>decrease</u> of over 27 percent in the other areas. Total man-years of labor per unit land also increased in Caxias by a similar magnitude, with a decline in temporary labor hired-in, whereas in the remainder of the country, even in comparably "backward" parts of Northeast Brazil surveyed, overall labor use declined substantially and the amount of temporary labor was stable or increased.

How are these differences to be accounted for? Part of the answer emerges from data discussed above. The gradual disappearance of an agricultural frontier in Caxias effected an increase in resident manpower within existing estates. New units were formed that incorporated some of the squatters forced to abandon state lands. While some of this growth

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[20] The N&P data show cropland representing 7 percent of total land area in the farms surveyed in 1963. The unpublished data from 1973 show cropland at 11 percent in 1973. Planted pasture on the seven farms was almost nil in 1963 and was 2.2 percent in 1973, nearly all accounted for by one farmer.

spilled-over into westward and rural-urban migrations, enough remained within rural properties of Caxias to be noticeable. At the same time, stability in the technical characteristics of agricultural production and land use, despite the shifts in property, led to the continuity in Caxias agriculture observed by Nicholls and Paiva between 1963 and 1973.

Another probable cause of the stability of farms of Caxias lies in the internal logic of the latifundia system itself and the absence of significant pressure for change from without in the period 1963-73. Latifundia insulate themselves from market volatility chiefly through enterprise diversification, as was quite evident in the Caxias farms surveyed by N&P.

The latifundia of Caxias were mixed enterprises, comprising livestock,[21] agricultural activities under shifting cultivation,[22] rudimentary food processing industries,[23] and

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[21] Landowners in 1963 averaged 163 head of cattle, 97 swine, 11 draught animals and 59 sheep or goats, while moradores averaged less than one head of cattle, three swine, one draught animal and three sheep or goats per household. By 1973, landowners had reduced livestock inventories somewhat, but moradores had been forced to part with most of the cattle reported ten years previous, although their swine herds had increased.

[22] Cropland in 1963 averaged only 2.2 ha. per permanent resident household. Landowners averaged 22.8 ha. in crops on their own account. The vast majority of cropland was planted to intercropped rice, corn, beans, and cassava. In a few cases, landowners also produced small amounts of cotton as a cash crop. Land in cotton disappeared almost entirely from the survey farms by 1973, in response to the fall of Maranhão's once proud textile industry.

[23] All farms had at least one cassava flour mill (one farm had nine); two had sugarcane rum (cachaça) distilleries.

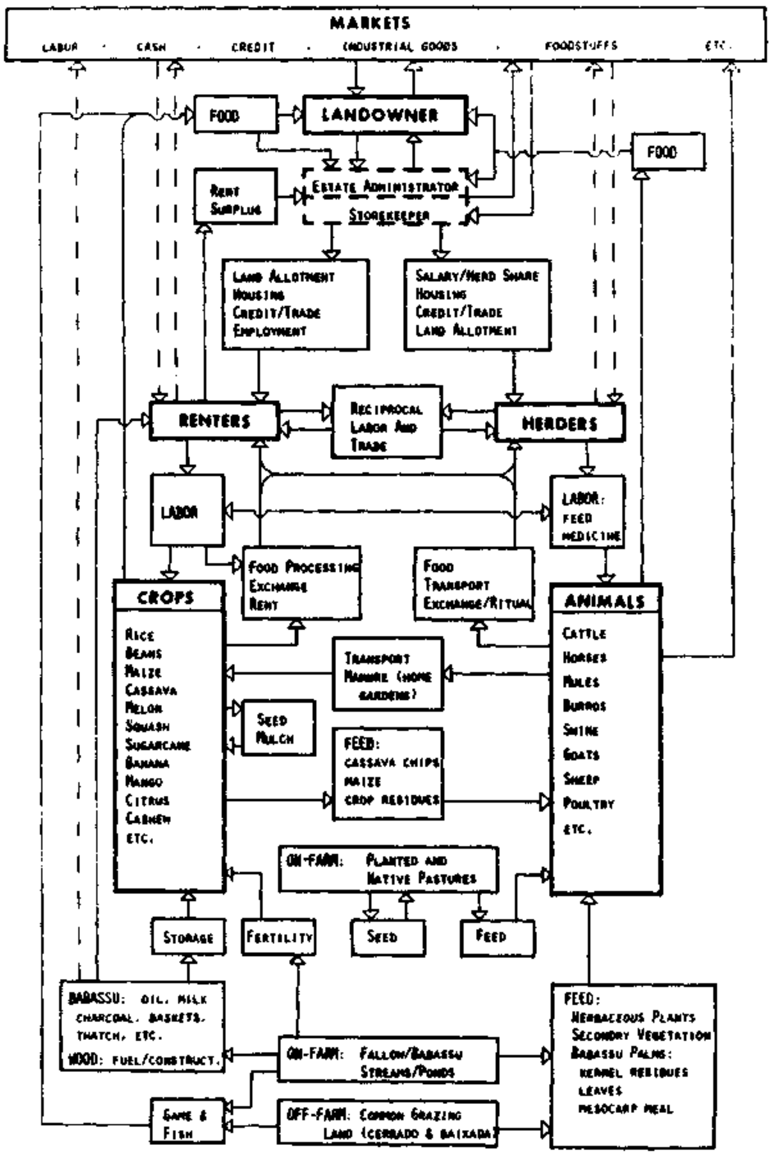

Figure 4.2. Schematic diagram of typical latifundia of the babassu zone (after concept in McDowell & Hildebrand, 1980).

Table 4.3. Sources of gross farm income, Caxias farms surveyed by Nicholls and Paiva: 1963 and 1973, in constant 1973 cruzeiros[a] per ha. in farms (W. H. Nicholls, unpublished data).

SOURCE	1963		1973	
	Cr$	%	Cr$	%
Rice	42.58	27.2%	36.49	20.6%
Beans	11.00	7.0%	31.11	17.5%
Maize	10.64	6.8%	10.41	5.9%
Cassava[b]	32.17	20.5%	39.90	22.5%
Other[c]	3.76	2.4%	0.14	0.1%
All Food Crops	100.15	63.9%	118.05	66.6%
Cotton	18.26	11.6%	2.08	1.2%
Babassu kernel	18.02	11.5%	36.91	20.8%
Cash Products	36.28	23.1%	38.99	22.0%
Beef cattle	10.99	7.0%	9.39	5.3%
Milk[d]	1.83	1.2%	1.90	1.1%
Swine	6.41	4.1%	5.82	3.3%
Other livestock[e]	1.09	0.7%	0.19	0.1%
All Livestock	20.32	13.0%	20.32	11.5%
GRAND TOTAL	156.75	100.0%	177.36	100.0%

[a] One 1973 cruzeiro (Cr$) = US$ 0.167 in 1973 current dollars.

[b] Includes both tubers and farinha.

[c] Cut forages, sugarcane rum, and miscellaneous other crops.

[d] Commercial production only.

[e] Does not include poultry production.

the omnipresent babassu kernel extraction activities and their trade for food and other commodities in one or more stores on the property. Figure 4.2. is a diagram of interactions among enterprises within typical latifundia in the babassu zone, based on a graphical scheme used by McDowell and Hildebrand (1980). These latifundia in some cases could be described as veritable communities, with schools, chapels, playing fields, and small processing industries. Their isolation from the municipal seat reinforced their semi-autonomous character as production-consumption units.

According to N&P, these enterprises derived nearly three-quarters of their gross incomes in 1963 from crop production and cassava flour manufacture. Cattle, pork and milk production for consumption and sale and marketing of babassu kernels accounted for the bulk of the remaining income (Table 4.3.) Of this income, 73 percent was generated by moradores, who obtained cropland and babassu palm stand use rights in return for marketing their surplus through the landowner, or in a limited number of cases, by payment of a fixed rental in rice. In addition to the rents derived from commercializing morador production, landowners also derived nearly half their net cash incomes from cattle and a small amount of milk sales. Proprietors applied nearly three-quarters of the working capital obtained in cash and kind from these operations and credit sources to their own crop production and to babassu kernel purchasing. Working capital outlays on crop production were mostly derived from credit;

babassu kernel purchases were financed by in-kind exchanges of goods from the estate stores, much obtained from the moradores' own production as rent or surplus. Livestock received little working capital investment beyond payments to herders, who received a one-quarter share of the calves they raised, in effect financed from natural herd increase. There was little if any productive capital investment undertaken among the properties visited.

The productive asset base[24] of the Caxias farms in 1963 consisted primarily of cattle and land, accounting for 65 percent of total fixed asset value among the seven privately owned properties. Since unimproved land in Caxias was valued by N&P at only $1.00 per ha., livestock represented landowners' major asset base, constituting about half of the total value. Yet, breeds were unimproved, range management was minimal, planted pasture almost nonexistent and feed rations and supplements limited nearly exclusively to crop residues and mineral salt. The herds procreated slowly; surviving calves allowed proprietors to sell and consume a small off-take of about 10 percent annually, marketed when they reached 100-150 kg. of marketable beef weight[25] at three or more years of age.

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24 "productive" assets, in N&P refer to property improvements used for farm income generation (e.g., reservoirs, stables, cassava flour mills, etc.), the land itself, farm equipment and draught animals, and productive livestock.

[25] Brazil employs fixed beef yield ratios to ascertain market value for cattle of given weight; for rangefed cattle, this ratio is about 47 percent of carcass weight (Robert McDowell, personal communication).

By 1973, enterprises had changed little. The immigrant who secured title to state land bought a tractor on credit in 1972, and put nearly one quarter of his 460 ha. into production. A 4,000 ha. latifundium which had attempted mechanized crop production had completely decapitalized by 1973, however, so the net change in average farm equipment value among the survey properties was slight. One of the latifundia had consolidated an additional four properties where the owner had established babassu oil, sawmill and rum industries. This estate was a clear representative of what we have called the LD property. The landowner was nonresident, having installed a "Secretary" to keep track of the inflows of rents and outflows of processed goods and a veterinarian to care for the herds. A number of cowboys kept the cattle more or less within the confines of the five properties. Fourteen administrators ran stores scattered among the estate's villages, receiving payment in the form of shares of in-kind rents and babassu kernels exchanged with resident moradores. The moradores themselves divided their time among crop production, babassu extraction, and sporadic work in the processing industries "when needed." They had few other opportunities to earn wages on the property except from one another and the administrators, as the landowner had no crop production on his own account.

The principal change in morador enterprises since the 1963 surveys was a reduction from 2.2 to 1.4 ha. of cropland cultivated per resident household, a change affected by the previously mentioned increase in the resident workforce and growing land constraints. This change may help to explain a shift in proportional importance of babassu extraction to represent over one-fifth of gross farm income among properties surveyed (Table 4.3). The decrease in available cropland and decline in the cotton industry placed added pressure on babassu stands to provide a base for peasant and landowner livelihood. As will be described in greater detail in Chapter VII, the period 1962-73 was one of rapid growth in the state's industrial facilities for babassu kernel oil production. Regional industrial growth is also a factor explaining the growing importance of babassu to Caxias farm income, as a response to growth in raw material demand.

In contrast, other areas of Brazil had initiated a general process of agricultural transformation that entailed far greater alterations in the rate of capital and labor use. Nicholls and Paiva (1979:27-28) describe these overall trends, as observed on the survey farms of the dry Northeast and South-Southeast as follows:

> Generally, the production of cassava, beans, corn, and pork in 1963 was done mostly for the subsistence of smallholders or worker families, whose numbers had sharply declined in 1973, to the extent that highly mechanized crops such as soybeans-wheat substituted the labor-intensive ones like coffee and intercropped subsistence crops, or greater areas of corn and cassava were planted on the landowner's part; planted pastures for cattle production dislocated more and more land formerly used for crops; and the remaining bean and corn production became relatively more commercial, in this event likely produced by the landowner employing more mechanized means. In consequence, these major modifications in the crop- livestock composition appear to be closely associated with reduced labor

> requirements, with changes to land use with an increased number of hired workers and a reduction in the system of agregados and moradores with rights to small plots to plant their food, and to increasing mechanization.

As we have seen, Caxias farms, rather than experiencing a decline in the number of resident workers, showed an increase. Mechanization had not made significant inroads nor had planted pastures displaced cropland. Continuity rather than the generally rapid shifts in factor proportions experienced elsewhere in Brazil characterized Caxias agriculture from 1963-73.

The process of mechanization in Brazilian agriculture began in earnest in the late 1960s, in concert with the so-called "Economic Miracle". The model of accelerated development adopted by the Brazilian military regime led to agricultural policies sharply skewed toward land and capital rather than labor-intensive technology (Sanders and Ruttan, 1978; World Bank, 1982). The focus of publicly-subsidized investment in agriculture was on export-oriented plantation monocrops, particularly soybeans, wheat and citrus (Graham et al., n.d.), and beef cattle ranching (Hecht, 1985). Despite the more dramatic shift from domestic food production to export crops in the South and Southeast of Brazil than in the dry Northeast, Nicholls and Paiva encountered declines in labor use underway everywhere they went in 1973 except for Caxias. In the South and Southeast, which had historically been more responsive to policy shifts and were closer to the centers of agricultural input and capital industries, this was understandable, but the dry Northeast, which enjoyed none of these locational advantages, exhibited similar factor substitutions. What is interesting is the tardiness with which these transformations arrived upon the rural scene in Caxias.

It is possible that the extractive economy based on babassu kernels enabled Caxias to shift from its previous cotton-livestock-food crop enterprise mix to one in which babassu kernels became a more important component of landowner rents, thus avoiding severe dislocations. Because babassu extraction demanded appreciable labor input, the retention and even expansion of the resident laborforce is a consistent outcome. Yet, the transformations evident by this time in Brazilian agriculture as a whole were not to be held in abeyance for much longer in Caxias.

The Economic Miracle Comes to Caxias

Agro-industrial development stimulated by national policy instruments rather than adjustments within existing agricultural enterprises led the transformation of rural Caxias between 1973 and 1983. Federal stimuli for import substitution of fuels and other intermediate goods in combination with tax deferment for Southern firms investing in the Northeast and Amazon regions made the Itapecuru and Parnaiba Valleys attractive as sites for sugar, ethanol, and cellulose mills. The investment groups responsible for these operations typically assembled properties formerly under LD property control to avoid transactions costs, and established the agricultural or silvicultural components largely on project property.

In Caxias and neighboring municipios[26] a number of major latifundia were disposed of, including the LD property described in the previous section. The moist bottomlands nearest to the mill sites were converted to cane and Caribbean pine plantations; bamboo was also planted on hillsides to substitute for babassu palms as a feedstock for cellulose production. The palms, growing most densely along the fertile streambanks, were clearcut. It has been estimated that one project accounts for about 6,500 ha. of babassu stands being cleared each year (INEB, unpublished memo[27]). By 1991, clearcutting of babassu is expected to cease, as there will be no more palms left to cut within the group's 60 km. radius of action.[28]

On the drier savanna uplands, firms planted drought-tolerant Australian eucalyptus to be used as fuel for the mills and eventually for cellulose. The pine, bamboo, and eucalyptus plantations benefited from a reforestation sectoral

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[26] The mills were actually sited in the municipios of Coelho Neto and Aldeias Altas (the latter had split-off from Caxias as a separate administrative entity in the early 1970s), with project property covering a number of surrounding municipios. Nevertheless, Caxias is the principal population and market center, and houses a regional sugarcane experiment station to support cane growers in the region as a whole, run by PLANALSUCAR, a federal agency.

[27] "Devastação de babaçuais pelo Grupo João Santos no Municipio de Buriti-MA." Unpublished document. Instituto Estadual do Babaçu, Maranhão.

[28] Interview with manager of an agro-industrial project in the region.

investment fund administered by the Brazilian Forestry Development Institute (IBDF). Since this program was established, over 12,000 ha. have been planted in eucalyptus, nearly 4,000 ha. in bamboo, and 5,000 ha. in pine in Maranhão's cerrado.[29] Other areas were cleared for pasture establishment; one of the two major investors developed a 10,000-head beef cattle operation of improved Nelore Brahman stock.

Besides pulp and paper, the development projects involve sugarcane production, sugar refining, and ethanol distilleries. Perhaps one of the most impressive accomplishments of Brazil's recent policy initiatives has been the rapid response of agro-industry to the policy of ethanol production to substitute foreign petroleum as an automobile fuel. Brazil relies on imports for most of its petroleum requirements. In response to the price shocks of 1974 and 1979, the government developed Pro-Alcool, an accelerated program of sugarcane-based ethanol production and conversion of the national automobile fleet to run on pure fuel ethanol. Although Pro-Alcool's secondary objectives, such as biomass diversification, rural employment and the redressing of regional inequalities have not been met (Saint, 1982), Brazil achieved a dramatic increase in ethanol production.

Production of ethanol reached the 1980 target of 3.6 billion liters, and more than doubled this attainment by 1983. To provide the principal feedstock for this effort, sugarcane

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[29] Interview with IBDF official, Maranhão.

output increased between 1970 and 1980 at an annual rate of 7 percent, as a result of massive cropland substitution from food crops primarily in the state of São Paulo (Graham et al., forthcoming; World Bank, 1982). A planned expansion to 10.7 billion liters by 1985 has been more difficult to achieve.[30] The achievement of the 1985 goal implies that even with dramatic yield improvements in both cane production and processing, sugarcane producing lands would need to approximately double from their 1979 levels to around five million ha. throughout Brazil (World Bank, 1982). This level would account for about 13 percent of all land in annual crops in Brazil in 1980 (IBGE, 1984b). However, if the experience of the refineries in Caxias offers any indication, the program continues to expand dynamically, and is bringing about substantial modification in agricultural land and labor use wherever its effects are noticed.

The firms in Caxias are typical of the large-scale alcohol and sugar refineries brought on line through Pro-Alcool. One firm in Caxias planned daily production capacity of 1,400 tons of sugar and up to 200,000 liters of fuel

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[30] In the early 1980s, thre was a major slump in demand for automobiles in general due to Brazil's economic crisis; a crisis in consumer confidence due to mechanical problems in the first generation of alcohol cars was another cause for this slump. However, this appears to have ended with a gradual upturn in the economy and the continuing low international sugar prices which have justified diverting cane to further growth in subsidized ethanol production.

alcohol refined from residual molasses.[31] Sugarcane production in four of the municipios[32] supplying the mills had increased from 3,325 tons in 1975 to 463,620 tons in 1980 (IBGE, 1979 and 1984a). At current yields of 50 tons of cane per ha., this production accounts for 9,270 ha. in sugarcane in these municipios in 1980. It is estimated that, to supply only the above described mill's requirements, the area in cane would have to increase to 48,000 ha.[33] By all accounts this leap had been accomplished by the time of my visit in 1984; the firm now plans to double its current alcohol capacity, and expand sugar production commensurately. Bagasse (the fibrous residue from sugarcane crushing) is used as a fuel in the sugar and ethanol mills as well as for cellulose in the pulp and Kraft paper mill run by a separate subsidiary of the João Santos group, a diversified agro-industrial products corporation from the state of Pernambuco.

The repercussions of these pharaonic schemes upon the relatively unaltered face of Caxias agriculture were readily apparent from my 1983 update of Nicholls and Paiva's survey. Their future implications for labor and land use may be similar to the changes experienced in other regions of Brazil

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[31] Since the 1930s, Brazilian sugar mills have been established as joint product operations, with the excess molasses being converted to ethanol as a fuel additive. Another option is to divert a portion of the fermentable liquors otherwise used for sugar production to the distillery as dictated by relative price conditions (Daniel Gross, personal communication).

[32] Coelho Neto, Aldeias Altas, Caxias and Duque Bacelar.

[33] Jork Sellschopp, personal communication.

where comparably scaled sugar/fuel ethanol facilities have been rapidly developed as a result of Pro-Alcool (Gross, 1985).

Of the seven farms visited by Nicholls and Paiva in 1973, only three were in the same hands a decade later, and only one of these was operated in a manner similar to that described by the 1973 data. Another of the three had been divided and 4,000 ha. sold to an investor from the state of Pernambuco who was at the time of my visit clearing the entire property to establish a pasture operation, both for seed and cattle. The immigrant farmer who had initiated mechanized crop production in 1973 was producing sugarcane for one of the new mills, supplanting his former production of food crops, cotton, and castor bean. He and many other regional producers were attracted to cane growing by Pro-Alcool's production credits at 35 percent nominal rates. (With inflation over 200 percent annually, these credits translate into negative interest subsidies.) Landowners produce under contract to the projects; their guarantee of sale assures them access to credit to cover input costs.

The LD property which in 1973 contained over 15,000 ha. and 350 resident households had been transferred to one of the project groups and was converted principally to sugarcane production. Moradores and small landowners within the areas closest to the mills were retained as workers and managers of cane plantations, receiving direction, land preparation, and inputs from the firms' agricultural subsidiaries, which provide custom equipment services and manage cane production to meet mill specifications.

One of the medium-sized properties close to the city of Caxias, previously a dairy farm, had been transferred to the owner of a large-scale vegetable oil and soap factory. This firm was one of the largest consumers of babassu kernels in Maranhão. On the property, the new owner had initiated a 500-ha. mechanized, irrigated tropical soybean and banana operation, together with a herd of Nelore steers. The soybeans were to serve as the vanguard for a transformation of the vegetable oil industry in the state from babassu kernel to soybean crushers. Land conversion to sugarcane, tree plantations, and pasture had begun to take their toll on babassu kernel supplies in an area where, as shown in Table 3.8., 94 percent of existing supplies are being extracted.

What are the implications of these changes for the moradores of Caxias? Detailed current data could only be obtained for three of the seven properties included in Nicholls and Paiva's 1973 survey.[34] The data obtained for the additional farm properties was insufficient to provide estimates of their current population to land ratios. These

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[34] I was unable to complete detailed follow-up surveys of the following farms: the mechanized soybean operation above; an LD estate which had been forced into receivership due to over-leveraged investment in mechanical equipment, thereupon transferred to INCRA for distribution to its morador residents; the LD estate sold to one of the agro-industrial firms for sugarcane production; and the property converted to sugarcane by the immigrant farmer from Ceará. However, I interviewed their current managers or previous owners to obtain the details provided above.

enterprises had shifted radically from their 1973 status, with considerable reduction in permanent labor use in most cases. On the three properties which had continued under the same ownership and general enterprise characteristics, the number of permanent resident households had also decreased, in one case drastically, due to sale and conversion of 80 percent of the property to pastures. The amount of cropland cultivated by each of the remaining resident households had remained roughly stable at about 1.3 ha. However, moradores throughout the region had access to considerably less land for shifting cultivation, given the conversion to cane, pastures, soybeans, and tree plantations. On the three farms, the resident population density in 1983 had increased 70 percent over the average for 1973, reflecting increasing difficulties in securing access to land.

Seasonal rather than resident labor use had become the norm on those properties now engaged in sugarcane production. According to informants, the great majority of workers on the cane plantations are "boias frias" ("cold lunchers"[35]) who are paid on a tonnage basis during the cutting season. To obtain the greatest possible income, all family members are engaged in cane cutting; thus the time available for complementary activities such as babassu collection and subsistence crop production is sharply curtailed.

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[35] So-called because they must carry a lunch with them to the fields, rather than being able to enjoy the traditional warm lunch, in Brazil, the main meal of the day.

Although most of the boias frias are residents of the region, many are moradores on noncane farms who complement their own subsistence production with cash income from daily wages off the farm where they reside. As land for subsistence production becomes scarce, boias frias have more and more migrated to urban centers where they place a growing strain on social services and housing. The agro-industrial project managers have become the new *patrões*, but they are distanced from the workers by several layers, e.g., labor contractors and cane plantation managers. Agro-industrial project managers' sentiments toward their employees are summed-up in the comment made to me by one informant that "the local people are docile; as long as their bellies are full, they don't complain."

Conclusions; Susceptibility to Change

As described by the Caxias experience, some of the older settled regions of the babassu zone are coming under increasing pressure to alter land use and agricultural enterprises. The large latifundia were apparently the first to be transformed. One reason for this is found in a weakening in latifundia's internal resilience brought about by the shift from cotton to babassu as cash products and from mandatory commodity exchange to fixed in-kind payments as predominant methods for extracting rents. Although a property taxation structure which penalized withholding land from production had been established as a means of bringing about land use intensification, owners of latifundia wielded political power sufficient to defer tax payment. It was not until federally subsidized investment in agro-industrial ventures stimulated the local land market that the landed aristocracy became willing to part with their properties. Medium-sized properties adapted to the new markets by converting to mechanized cane and soybean production, reducing the resident workforce, and hiring-in day laborers for seasonal requirements.

With alteration in rural enterprises, and the gradual enclosure of former state lands, peasant farmers have been subjected to increasing difficulties in securing access to land for shifting cultivation. In the Caxias case, the resident population density on estates still employing a morador workforce had increased, particularly during the period 1973 to 1983. To supplement subsistence crop production from a reduced accessible land base, the landless are being transformed into a seasonal laborforce of boias frias. The conversion of land to feedstocks for cellulose and cane distilleries has directly affected the area in babassu stands, placing added pressure on nearly fully exploited remaining resources.

This chapter has examined the characteristics differentiating rural enterprises in the babassu zone. The typology formulated above provides a basis for estimating the share of regional land held under different property regimes. The diachronic perspective offered by analysis of farm management over the past twenty years among farms of Caxias serves as one base from which to predict the changes in store for the babassu zone. This analysis must be combined with a comparable perspective on the parallel yet distinct processes that are causing shifts in agrarian structure and land use in the cocais sub-region. These processes will be examined fully in Chapter VI. First, however, it is necessary to plumb in more depth the conditions of the peasantry and the specific character of the "subsidy from nature" they derive from the babassu palm. Only then will it be possible to ascertain what alterations in property rights to land and palms entail for peasant welfare in the babassu zone.

CHAPTER V

BABASSU IN PEASANT FARMING SYSTEMS OF MARANHAO

The landless peasantry of the babassu zone is effectively cornered by "push" factors of agricultural modernization in the older settled areas of the semi-arid Northeast and a rapidly closing Amazon frontier. Those able, however tenuously, to remain in agriculture still produce food to survive, give landowners their due, and provide sufficient surplus for urban consumers. The peasant's shifting cultivation system associated with babassu extraction has been shown in the previous chapter to be unstable within the context of agrarian change. The constraints and pressures affecting agrarian structure and peasant welfare in the cocais subregion of the babassu zone are to be revealed in Chapter VI.

The characteristics of peasant farming systems which incorporate babassu palms as an element are elucidated in this chapter. Specifically, the interactions within the household economy of babassu and crop production as well as animal husbandry are described in depth. The aim is to value the benefits derived from babassu to households in the two study subregions as well as between tenure strata within survey areas. This information supports an assessment of the social costs of babassu eradication and access delimitation and, as well, suggests options for equitable development strategies based on native plant resources.

The Cropping System

Agricultural technology is uniform in its rudimentarity across peasant production systems in the babassu zone. Nevertheless, the peasant *roça*, or annual shifting cultivation plot is the principal source of food grown in the region. Rice, by far the region's most important crop economically, is employed for in-kind payment of land rental, as a cash crop, and a principal source of sustenance. Over 125 regional upland varieties selectively developed by small farmers have been identified (Fonseca et al., 1982). The aim in seed selection is typically one of assuring a minimum yield level that will enable the peasant household to provide for the fixed land rental as well as assure some consumption and seed for the next year's planting. There are years, however, when drought reduces yields below this minimum level, in which case the landowner must forego rents if he wishes to maintain the workforce on his property. Most of the survey households in 1983 were faced with low yields as a result of the drought; some proprietors in these cases deferred rent payment or adjusted their demands to a share of the reduced output.

Rice is the principal component of an intercropping system which also includes local maize varieties. The latter are rarely sold, being used primarily as feed for animals and cornmeal for human consumption. Bitter cassava, often included in the roça, is used for making flour ("dry" or fermented "_farinha d'agua_"[1]), which is a basic staple. Cowpeas and lima beans, planted around the corn stalks or on a separate plot, are also primarily for subsistence consumption. Among other crops planted are squash, watermelon, West Indian gherkin (_machiche_), okra, cucumber, a leafy sour herb called _vinagreira_ used in making the local condiment _cuxá_, and banana. Of these, only banana is a major cash crop, planted particularly by small farmers in the cocais.

The majority of the four principal crops are produced by the landless on areas under five ha. (Table 5.1). Although they occupied only 9.3 percent of all agricultural land in 1980, renters, sharecroppers, and squatters produced over two-thirds of the rice and maize, and about three-quarters of the cassava and beans grown in Maranhão in 1980. Maranhão is one of the major rice producing states of Brazil, even with traditional methods.[2] Two-thirds of the rice output in 1980 was accounted for by enterprises under 20 ha. in size, which I have defined as landless or near-landless peasant farms in Chapter IV.

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1 "Dry" farinha is made by peeling and grating cassava tubers, squeezing part of the mildly toxic hydrocyanic glucosides from the gratings, seiving, and then roasting the meal on an enormous tin or ceramic pan over a fire. _Farinha d'agua_ is made by first soaking the peeled tubers in fresh water for three days, and then following the same procedure. The result is a more granular, crunchy meal with a slightly acid taste. Farinha is eaten raw as a side dish with rice and beans, and in times of scarcity, is the principal staple.

2 In 1982, Maranhão, using predominantly manual cultivation techniques, was responsible for 16 percent of Brazil's rice crop. The leader was Rio Grande do Sul with 27 percent, produced primarily under mechanized cultivation (IBGE, 1984b).

Table 5.1. Production of principal food crops by farm size and tenure, Maranhão: 1980 (IBGE, 1984a).

CATEGORY	AGRICULTURAL LAND (%)	SHARE OF STATE PRODUCTION (%) Rice	Maize	Beans	Cassava
FARM SIZE					
< 5 ha.	3.9[a]	52.0	55.0	63.1	72.6
5 - 100 ha.	13.6	29.3	29.4	26.2	20.2
> 100 ha.	82.5	18.7	15.6	10.7	7.2
Total	100.0	100.0	100.0	100.0	100.0
LAND TENURE					
Landowners	90.7	35.9	32.9	28.0	20.4
Renters	3.3	33.5	33.6	40.0	32.7
Squatters	6.0	30.6	33.5	32.0	46.9
Total	100.0	100.0	100.0	100.0	100.0

[a] Of farms under 5 ha., only 4.8 percent are held as private property; the remainder are located on others' estates or state lands.

The contribution of peasant farms to the wage food requirements of both the Brazilian Northeast and the urban-industrial Southeast has been a subject of debate regarding the "functionality" of the peasantry to capital accumulation (Brandão Lopes, 1973; Oliveira, 1972; Sá, 1973; Sandroni, 1980). Because peasants' labor in the roça provides for both subsistence needs and a surplus for market, it reduces the cost of foods required by urban consumers. The latter's wages can be held in check, according to the dominant argument in this debate, because of the low cost of labor reproduction. Hence, the nation is better able to develop industries which, due to their low wage bill, are able to compete with imports on the domestic market, and to enter foreign trade. Peasants are able to perform this function by balancing labor allocation among the roça, off-farm employment, and extractive activities. For the latter, they rely on a "subsidy from nature" derived from subsistence and cash products they extract from native plants such as babassu palms (Hecht et al., n.d.).

The landless producers and small farmers interviewed for this study cultivate annual roças with median areas of 1.2 ha. in the cerrado, and 1.7 ha. in the cocais.[3] The size of the annual roça as well as its productivity is related to an array of factors. Besides the fundamental variations in agro-ecological conditions affecting soil fertility and crop growth, productivity is strongly affected by the number of the household's constituents who are economically active, and their ability to supplement household labor with hired labor and inputs financed from off-farm wages, livestock, credit, and babassu product sale.

The link between babassu and the roça varies in intensity for different types of producers. Position in the hierarchy

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[3] Roças are measured in <u>linhas</u>, which are 25 square <u>braças</u> and equivalent to 0.303 ha. There are hence 3.3 linhas per ha. The plots are often fragmented since rice performs best on limited bottomlands, while cassava, which demands less moisture nutrients, can be planted on upland soils.

of producers bears an important relationship with the role of babassu in the production system. This section describes the interplay between the palm and agriculture in traditional systems, as practiced by the peasant farmers who form the wide base of the babassu zone's social pyramid.

Labor and Technology in the Roça Cropping Cycle

As described in Chapter II, babassu-associated cropping systems are agroforestry techniques that involve annual crops interplanted within palm stands that are thinned and burned for shifting cultivation. The importance of babassu as an element in shfiting cultivation practices is analyzed below with reference to the pattern of labor allocation and income generation by household members among crop production and babassu-related activities. The data were obtained during weekly interviews over the nine-month crop cycle from October, 1983 to June, 1984 with 42 landless peasant and minifundio households who live on representative properties in Lima Campos (cocais) and Chapadinha (cerrado).

The households included in this study average 5.2 persons, of whom 2.8 were regularly involved in economic activities. The ratio of dependent to economically active persons is lower in the babassu zone than elsewhere in rural Brazil, because extractive activities employ women and children's time more fully than do general agricultural requirements (Nicholls, unpublished notes). The households sampled exhibit a considerable range in size, however, and are not stable in composition. This is because some active males migrate to mining, frontier agriculture, or urban employment either seasonally or year-round, so there are usually more women, children and older people in permanent residence within landless households. Children of school age often are sent to live in the nearest town to study, and return during holidays to help, particularly in land preparation, planting and harvesting periods. Given labor shortages, the households employed daily workers (50 percent of families surveyed used this strategy), or engaged in labor exchanges ("troca de dias") with other households to reduce labor costs and assure timely completion of essential tasks. Daily wages averaged the equivalent of US$ 1.50 in 1983-84, and usually included the provision of a meal to the workers, but small farmers often exchanged labor for a portion of the particular crop under cultivation, or for meat.

The average daily wage of US$ 1.50 would be sufficient for households in the survey to purchase their reported per capita consumption of 1.5 kg. of rice, 0.25 kg. of beans and 0.41 kg. of cassava flour, leaving US$ 0.65 to buy other goods.[4]

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4 per-capita consumption levels of the three basic staples are derived from households' reporting of weekly consumption from own production and purchases at local stores, all valued at local market prices and converted to US dollars at current official exchange rates. In Table 5.2., I compare these per-capita figures with those presented by Kutcher and Scandizzo (1981). The latter, based on FAO dietary data, are a described as representing a typical "low-cost" Northeast Brazilian diet. This they present as being affordable by the poorest strata, and meets standard protein and caloric requirements. Its cost in constant dollars was nearly

Table 5.2. Minimum diet composition and cost, 1973 "low cost diet" and 1983-84 actual consumption (Kutcher & Scandizzo, 1979; field surveys)

	PER CAPITA DAILY CONSUMPTION	
	1973	1983-84
	"LOW COST NORTHEAST BRAZILIAN DIET"[a]	REPORTED CONSUMPTION BY SURVEY HOUSEHOLDS
Rice	150 g.	290 g.
Beans	200 g.	50 g.
Farinha	400 g.	80 g.
Protein[a]	54 g	43 g.
Calories[a]	2,308 cal.	1,725 cal.
Cost[b]	$ 84.75	$ 78.00

[a] Reported by Kutcher and Scandizzo (1981) based on FAO dietary surveys. All protein and caloric values per gram of foodstuff are as reported by Kutcher and Scandizzo.

[b] Costs are in 1983 current US$. The reported cost for 1973 was US$ 37.96, and was inflated using the US Consumer Price Index. The cost of the "low cost Northeast Brazilian diet," if purchased in 1983-84 by survey households, would have been US$ 139.25 per capita per year, or nearly double the cost of the basic foods they actually consumed.

equivalent to that of my 1983 survey figures for average per-capita annual basic food consumption. It is notable that survey households in Maranhão relied far more upon rice for dietary requirements than the 1973 comparison, reflecting Maranhão's comparative advantage in rice production; per-capita consumption of beans and farinha was only about one-quarter that of the "low-cost" diet. The Maranhão respondents' overall protein and caloric intake from these three staples, however, was 25 percent below that of the 1973 diet. Although some households consumed meat and eggs to make up the deficiency, the poorest did not.

The per-capita consumption levels of the three basic staples alone would require an expenditure of about US$ 80 per person per year, if farmers' own production is not taken into account. Thus, to meet the minimum diet, a typical landless survey household having six members would need to earn at least US$ 480 per year, requiring 320 days of wage employment among active household members.[5]

In fact, however, households in the survey were able to produce about 55 percent of the basic food products they consumed in 1983-84 from their own output, produced with some work by all household members except the very young and the infirm. The number of days spent in wage labor averaged only about 80 days among all survey household members, principally adult men, from which they earned nearly US$ 125, or about one-quarter of the income needed for basic staples. After own production is taken into account, the remaining 20 percent of income to sustain the household at this bare minimum was derived primarily from babassu kernel and charcoal sales. There was considerable variation around these mean values, however, as well as different levels of importance of the various income sources at different points throughout the crop cycle.

The cropping cycle involves several distinct phases, divided broadly into land preparation, planting, weeding, and

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[5] In 1973, landless "permanent resident worker households" in the Western portions of the Northeast, including the state of Maranhão,. had average annual incomes equivalent to US$ 520 in 1983 dollars (Kutcher and Scandizzo, 1981:69).

harvesting. The land preparation phase involves first the demarcation of the new roça, often accomplished shortly after the rice harvest from the prior year's plot in June. The cropping area and specific site are determined for moradores by the landowner or administrator, in light of the producer's assessment of his household's labor mobilization ability and food consumption requirements for the coming year. In most cases, the producer will have identified the site he would like to work; whether he is allotted this parcel depends on the landowner's plans for the area. In many cases, the best land for slash and burn production — that which consists of the oldest secondary or (more rarely nowadays) primary forest growth — is withheld as a potential source of cash from timber or as a "soil bank" for a landowner's contemplated cropland or pasture establishment.

The choice of roça site is an important conjuncture, as it will determine the rent to be paid at the end of the harvest (a fixed rate varying on survey properties between 106 kg. and 317 kg. of rice per ha. cultivated,[6] which represents approximately one-fifth of average rice yields under traditional intercropping). Rents in the more productive cocais

[6] These figures correspond to the local measures of one to three alqueires per linha; one alqueire being equivalent to about 32 kg. of unhulled rice. Rental payment was normally in rice, regardless what crops were actually planted, though in some cases renters paid in beans, farinha, or made cash payments prior to initiating the roça. These alternative arrangements depended on the landowner. The stricture upon employing rice as principal in-kind rental payment responds to the crop's historical importance as a wage food, with well-defined market channels, and in practice ensures that most cropland is planted in rice (Maluf, 1977).

are higher. Most landowners there insisted on three alqueires per linha; in the cerrado, the norm was closer to two alqueires. Average rice yields in intercropped plots were 1,600 kg. in the Mearim microregion (cocais) and 1,050 kg. in the Alto Munim (cerrado) (IBGE, 1984a). Since cocais farmers typically cultivate larger roças, as described earlier in this chapter, there is a substantial difference in household food production between the two regions. Rents are nearly equivalent in percentage terms, but cerrado producers are left with significantly less rice for their own use or sale after rental payment than cocais farmers.

The producer in either subregion benefits considerably if the site chosen for the roça is well endowed with forest growth, on low-lying soils where rice performs best. The sites survey households cleared for the annual crop roça in 1982 and 1983 averaged 6.6 years since prior clearing, but ranged in age from less than one year[7] to "virgin" forest (over 60 years since last clearing). The reported fallow period averaged nearly 2.5 years longer for cerrado farmers beginning new land clearing than for those in the cocais, responding to the poorer overall edaphic and climatic conditions for plant growth in the cerrado, as well as pressures

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[7] In 1983, partly to avoid investing labor in an insecure new roça, due to the prior year's drought, many producers in the Cerrado communities surveyed re-used their prior year's roças, on the assumption that the low output from the previous year would have left much of the nutrients derived from the slashed vegetation in the soil. There was in general a considerably lower than average level of crop productivity on these sites in 1984.

upon agricultural land availability in the cocais. Land clearing first involves the "*broça*," in which farmers remove understory brush which can be cut with a machete or sickle. The next phase, more arduous depending on the age of the secondary forest is called "*derriba*," in which larger trees are cut with an axe. Polewood cut from the roça and nearby sites is piled on the fringes for fence construction to protect the roça from livestock left free to graze in the extensive unenclosed range of the cerrado. In the cocais, crop fencing is no longer necessary, as livestock are generally confined within permanently fenced pastures. After removing polewood needed for fencing, the remaining slashed vegetation dries in the roça for several weeks, after which farmers cut a corridor to protect adjoining properties, and the roça is set afire.[8] Shortly after the fire, farmers return to cut remaining vegetation, which they pile and reburn; this process is known as the "*encoivara*," and may be carried out twice, particularly in the cocais, where regrowth is extremely rapid. This phase then merges into a first weeding which immediately precedes crop planting.

With the first rain, usually in late December or early January, farmers plant seven to 10 grains of rice in holes about 40 cm. apart and maize in hills in rows up to five m. apart, among the rice. On sufficiently dry sites, cassava is

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[8] In a number of cases in the survey, fires were set involuntarily by spreading from adjoining properties, whether by malice, or error. Aceiros were also sometimes cut as part of the process of delineating the roça, rather than immediately prior to burning.

also planted close to these maize rows. Farmers usually plant some beans around maize stalks and babassu trunks during rice and maize planting. Toward the end of the rainy season, they often plant additional beans in a separate destumped plot, or scatter them about in the crop field at the time that rice matures, as a successional crop. Earlier in the season, farmers had randomly planted the other crops (e.g., watermelon, okra, squash, etc.) within the annual crop field. The soil is very rarely plowed, and no fertilizers are used, but farmers of sufficient means often apply herbicides during rice planting and, even more frequently, spray insecticide at the first sign of predation. Such practices were only found during this study among the cocais farmers. Cerrado producers and those of little means in the cocais depend on spells to ward-off pests; placing a chamber pot bottoms-up on a pole in the center of the roça is said to avert the evil eye.

Harvesting of annual crops begins in late March after two manual weedings, done with a short curved sickle; the soil is not cultivated. Farmers first harvest early rice varieties, green maize, and beans for household consumption. Most of the harvest period is devoted to rice, which is cut at the base of the panicle, leaving the stalks in the field for animals to graze, and to serve as a mulch to protect the soil and hold moisture for the still-maturing cassava. Regional rice varieties grow to maturity after completion of an average 120-day cycle. To avert risk, many households planted short-season varieties in 1983-84, after having experienced severe losses during the prior year's drought. Farmers store rice on the sheaf in a shelter (called a "paiol" — literally "cage") covered, with babassu leaves.

After breaking maize stalks during the rice harvest, farmers leave the ears to dry in the field until August to October, when they harvest them and store the kernels as grain. Farmers usually plant additional cassava on a lowland plot at the end of the rice harvest, which extends the life of the crop field. Banana planted under babassu also extends the life of the cropping system (Figure 5.1). Cassava varieties in use typically require up to 18 months to mature, after which household members harvest the tubers as needed for flour production, which peaks in the slack period before new land clearing. Once they harvest the cassava, farmers manage the babassu-dominant secondary forest fallow, periodically harvesting trees for polewood and lumber, and collecting herbs, leaves, fruit, and babassu palm products.

Survey households estimated that their total labor investment in the roça during 1983-84 was on the order of 207 person-days per ha. Table 5.3 shows the average per-hectare labor requirements for each activity, as reported by survey households in the cerrado and cocais subregions. Labor-sharing and wage labor utilization were essential during land preparation and harvesting when labor demands in the roça were greatest.

Figures 5.2.a-d describe the reported labor allocation by survey households to crop production and babassu-related

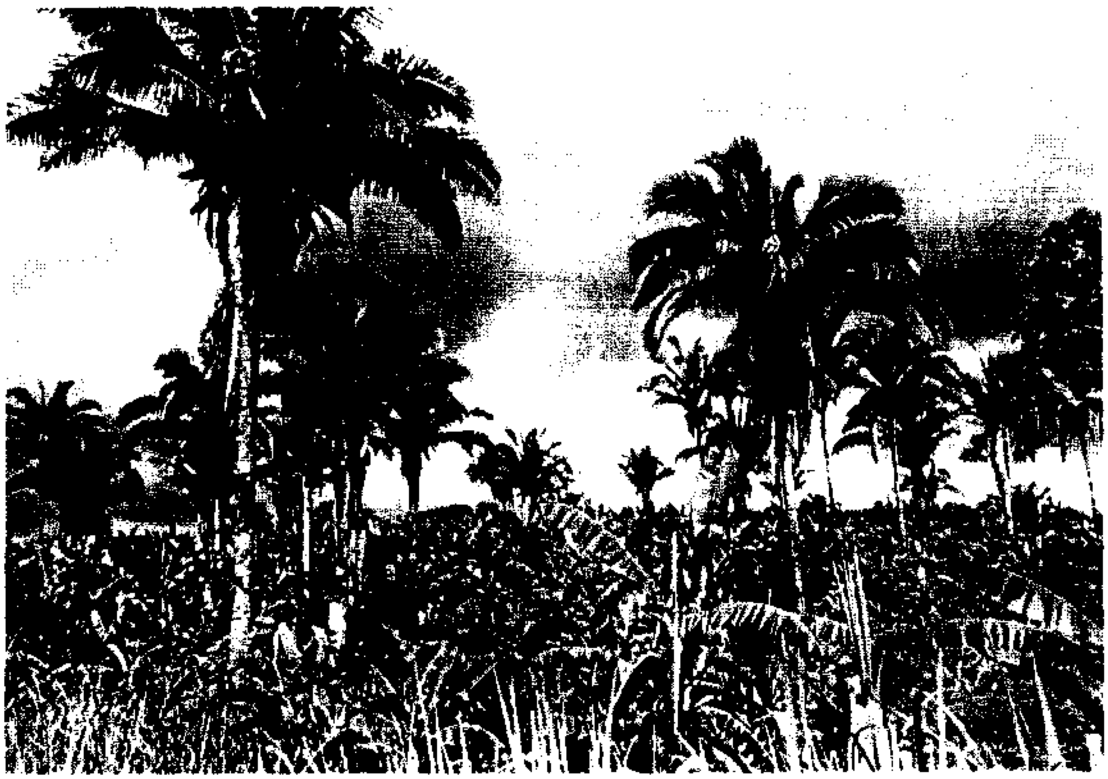


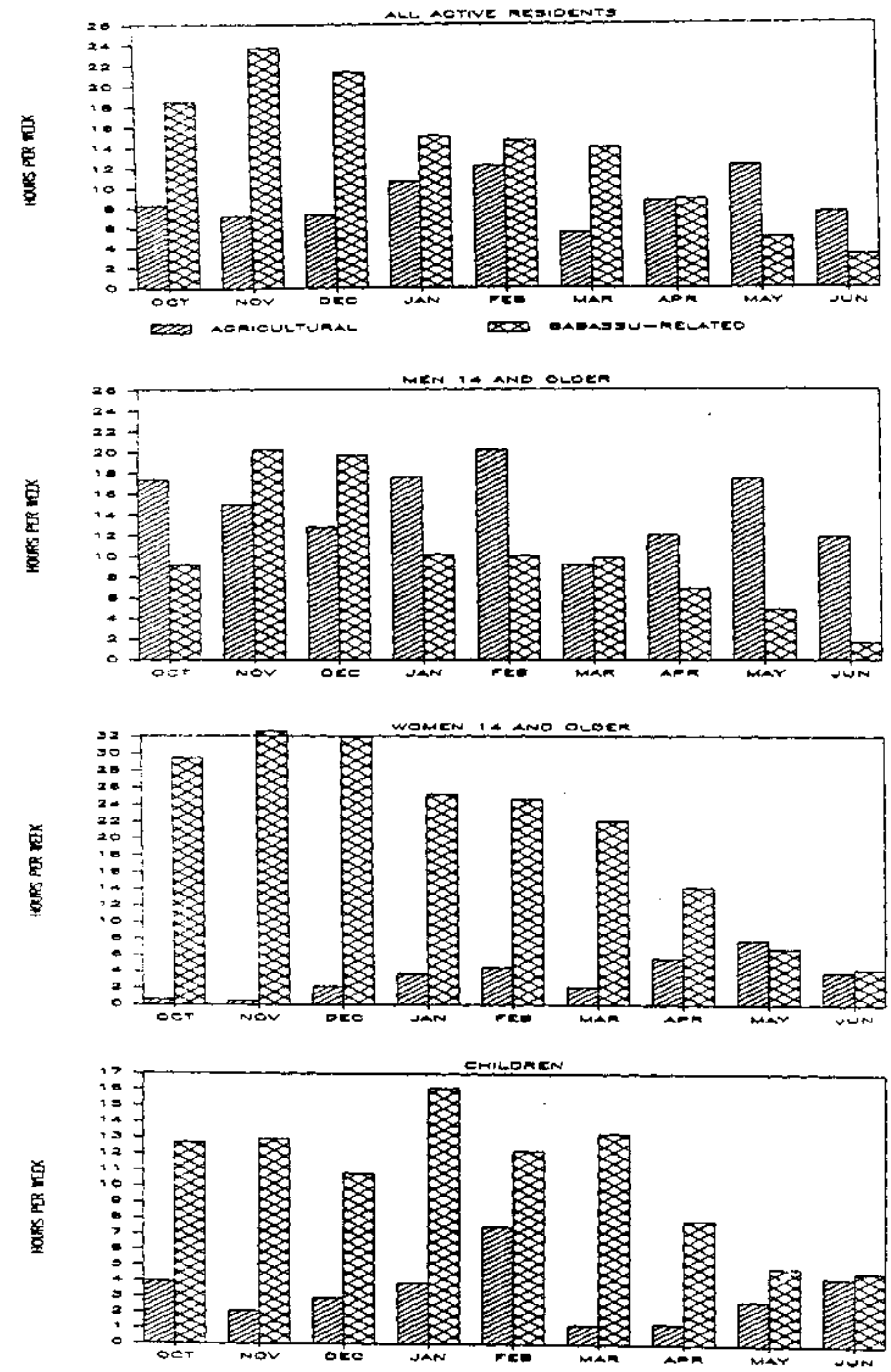
Figure 5.1. Bananas planted under babassu palms in Lima Campos, Maranhão.

Table 5.3. Labor requirements in the roças of Lima Campos and Chapadinha, Maranhão: 1983-84, person-days/ha.

TASK	CHAPADINHA	LIMA CAMPOS
Broca (brush-clearing)	19.8	15.1
Derriba (tree cutting)	7.9	6.0
Aceiro (border clearing)	4.4	2.3
Queima (burn)	3.4	2.9
Encoivara (final clearing)	8.5	9.4
Fencing	24.3	0.0
Planting	24.0	17.5
Weeding	33.9	26.6
Harvesting	50.8	38.1
Threshing[a]	6.3	9.4
TOTAL (person-days/ha.)	183.3	127.3
Avg. Area (ha.)	0.8	2.1
Avg. Labor per Household	146.6	267.3

[a] Based on data in Seguy (1982), assuming yields in the cerrado are two-thirds those in the cocais.

activities from October, 1983 to June, 1984. Men were dominant in land preparation activities, which occupied most of their time in October, but declined relative to babassu activities such as fruit and leaf harvesting and charcoal manufacture in November and December. From October to December, men devoted 38 percent of their time to babassu, and 35 percent to land preparation. Their remaining time went



Figures 5.2.a.-d. Labor allocation to crop production and babassu, Oct., 1983 - June, 1984, Lima Campos and Chapadinha, Maranhão survey households.

to wage labor, hunting, and animal husbandry. During the same period, babassu activities, chiefly fruit collection and kernel extraction, accounted for 81 percent of women's and 65 percent of working children's total labor.

With the arrival of rains in January, men shifted labor back to the roça for planting and weeding. Crop production occupied 48 percent of men's overall labor in January and February, while the amount of time they dedicated to babassu activities stabilized at about 10 hours per active man each week through March. Women reduced their babassu-related work to assist men on the roça, but babassu activities still claimed 69 percent of total adult female labor from January through March. Children made up for the reduction in women's time devoted to babassu. Their return from school in January contributed significantly to household labor available through March, during which period they devoted nearly two-thirds of their time to babassu activities.

With the onset of the crop harvest in April, agriculture dominated babassu in overall household labor allocation, being responsible for 35 percent of all members' work outlay, while babassu claimed only 23 percent. The swelling of streams with rain brought fishing as a complementary activity, while wage work predominated in many landless households' labor allocation strategies. The next section assesses the contribution of babassu activities to overall household income over the crop cycle.

<u>Subsistence Benefits from Babassu Palms</u>

Most small farmers report that babassu doesn't interfere seriously with crop production, so long as a low density of palms is retained. The principal problems that farmers associate with high palm density are shading, leaf fall damage, and excessive root binding of soils, impeding crop root penetration. To overcome these problems, shifting cultivators preferentially thin stands to between 50 and 100 adult palms per ha. They cut back the leaves to provide fuel for the burn. Dead leaf material still remaining in the palm crown is ignited with the burning of the roça. Together, these reduce the chance of leaf fall and consequent crop damage. The contribution of leaf litter and ash to soil organic matter and nutrient content and the ability to harvest fallow products appears to counterbalance root binding as a negative feature of babassu agroforestry.

The following sections detail the variety of forms in which babassu palms in crop fallows and other stands contribute to peasant income formation. First, it will be useful to describe the palm's fruiting characteristics. Babassu kernels, extracted from the fruit, constitute an essential source of cash income to peasant households. Yet, all portions of the fruit and the palms themselves have some use in the subsistence economy.

In the dense stands of the babassu zone, fruit bunches generally contain about 200 fruits, each of which average 190 g. in weight, 9.4 cm. in length and 6.0 cm. in diameter

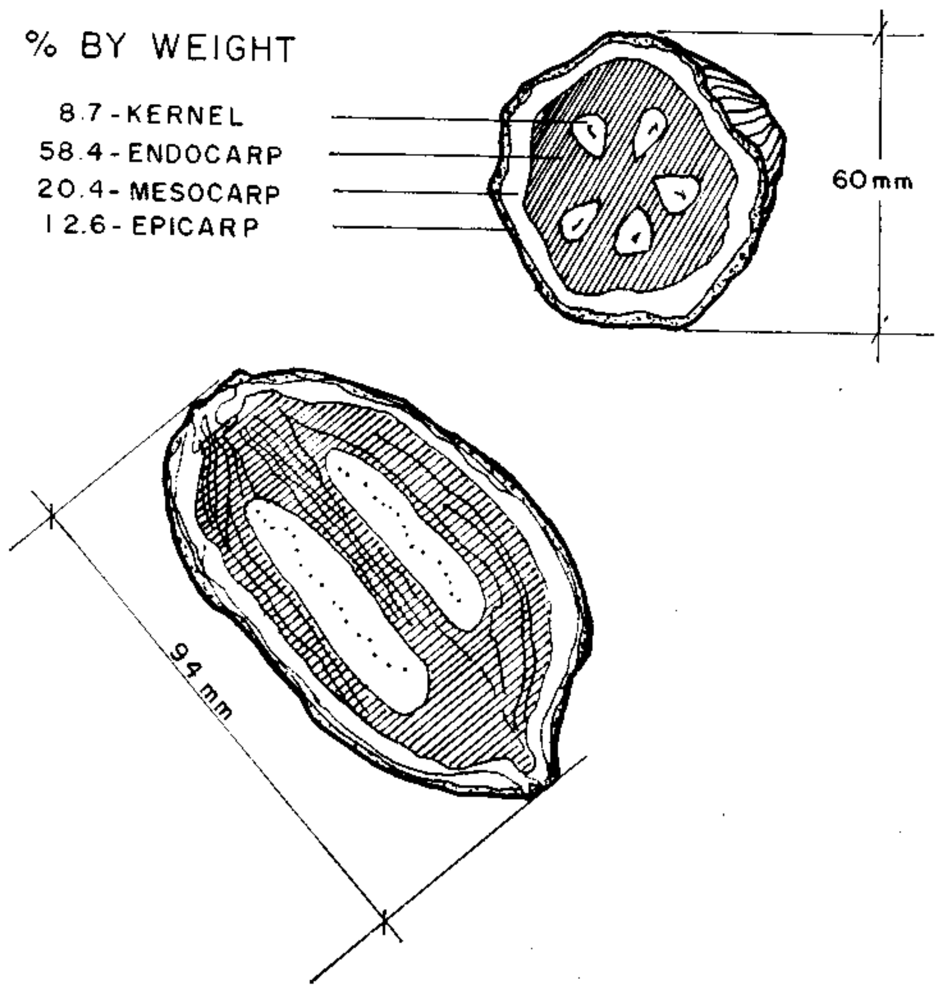


Figure 5.3. Average size and composition of babassu fruits collected in five states (Balick & Frazão, unpublished data).

(Figure 5.3). The kernels together represent on average only 8.7 percent of oven-dry fruit weight. Babassu kernel is similar in composition to coconut meat, having nearly equivalent oil content (about 66 percent) and fatty acid components. The principal free fatty acid (FFA) is lauric, comprising 46 percent of total FFA content (FTI, 1982), which gives these oils their desirable character for cosmetics manufacture (Swern, 1964).[9] Babassu kernels vary widely in number, with most fruit having between three and six kernels contained within a hard woody layer (endocarp) averaging 58 percent of fruit weight. The endocarp is composed nearly one-quarter of fixed carbon, giving it excellent qualitites for charcoal manufacture (Teixeira Leite, 1957). Surrounding the endocarp lies a layer of starchy material (mesocarp) which represents less than one-quarter of fruit weight, but consists nearly 70 percent of starch and carbohydrate (MIC/STI, 1977). The mesocarp, in turn, is surrounded by a thin layer of fibrous material (epicarp).

Babassu Kernel Production

Babassu collectors gather fruit predominantly from the ground, where they fall once ripe. During the peak of the harvest, people select fruits that contain the greatest number of kernels, as indicated by a fruit's size and shape. To extract the kernels, the fruit is placed on the edge of an

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[9] More details on the suitability of babassu kernel oil for various uses is found in Chapter VII.

upright hatchet blade and struck repeatedly with a wooden club until it splits (Figure 5.4). The broken portions are each in turn hit against the blade to dislodge the kernels. A skilled fruit breaker extracts most of the kernels without damaging them; broken kernels are more quickly subject to rancification and are hence less desired by the industry. Although potentially dangerous, few injuries are reported from breaking babassu fruits. As this activity commences as soon as a child is strong enough to manage it (generally at six or seven years of age), fruit breakers attain a high degree of skill.

Although most people can extract from three to five kg. of kernels in a full day's work, some occasionally produce considerably more. Since much of the time goes toward gathering the fruit in the forest (25 percent of the time devoted to kernel production[10]), those who break fruit gathered by others, a common practice especially in the cocais, will be able to devote more of the day to breaking alone and will produce more kernel. While babassu kernel extraction itself is perceived as an important source of income, people complain of the difficulty of gathering fruit, with the real threat of snakebite providing a tangible reason for its avoidance. Besides serpents, ranchers' erection of fencing and the increasing distance of collection areas from home sites are factors making fruit harvesting more difficult.

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[10] This figure probably errs on the low side, as many people interviewed were unable to separate the amount of time they spent gathering from that spent breaking fruit, when both were carried out in the forest.

Figure 5.4. Woman breaking babassu fruits, Maranhão.

Breaking of babassu fruits is considered women's work. Of total household time allocated to babassu kernel extraction, 81 percent was performed by women and children, whereas, in agriculture, men were proportionally more important. Men spend comparatively more of their time devoted to babassu extraction in collecting and transporting fruits to the home for others to break at a later time (37 percent for men versus 23 percent for women and children). In the original three study areas, nearly one-quarter of women interviewed broke fruits mostly in the palm forest, but close to two-thirds said they prefer to carry out this activity at home. Babassu fruit breaking is carried out complementarily with women's domestic activities as time permits. Women typically collect fruit in groups or with their children in the forest, and return to the home by mid-day to prepare a meal. Afterward, the breakers sit together in the shade, conversing while they work. One study found that women engage in labor exchanges in babassu kernel production (Anderson & Anderson, 1983); when time does not permit a woman to break the fruit she has gathered, she may invite a friend to break them "*por meias*" ("fifty-fifty"), or she will do an equivalent service for her friend on another day. Peasants in the babassu zone employ a variety of such labor and product-sharing arrangements to cope with peak labor requirements.

The proportion of cash income derived from the sale of babassu kernels is considerable. Overall, the households interviewed derived 29.6 percent of their adjusted cash income[11] from kernel sales alone over the nine-month survey period. The distribution of sources of income over the year also demonstrates the importance of babassu at key junctures in the crop calendar. Babassu kernel is particularly important as a source of cash income in the period between crop harvests. From October, when my survey began, to March, when households began to harvest green maize and beans, babassu kernels provided an average of 41.5 percent of total cash. After March, this proportion rapidly declined, due to competition with labor requirements in rice harvesting and the growing scarcity of easily accessible babassu fruit to gather. By May and June, kernel sales only accounted for about six percent of total cash income. Figure 5.5 shows the close relationship between the share of cash income derived from babassu kernels and the share of women and children's total labor invested in collecting and extracting them. This relationship was found to have an r^2 of 0.885.

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[11] Monthly income and cost data have been adjusted to correspond with October, 1983 prices, using as a deflator a weighted index of basic food prices. The three food items: rice, beans, and farinha, constitute the basis of the survey households' diets (constituting 40 percent of total cash outlays on food), as well as their principal agricultural products, constituting 56 percent of the imputed value of subsistence consumption. Their local market prices are considered to reflect the economic conditions facing producers in the babassu zone as they decide on how to allocate resources for survival. For this reason, this food price index was chosen over the national consumer price index as a measure of inflation. The index was devised by weighting the three food prices in accordance with their relative importance in survey households' diets, based on actual quantities purchased and consumed from own production, as reported weekly by the 42 survey households over a 9-month period.

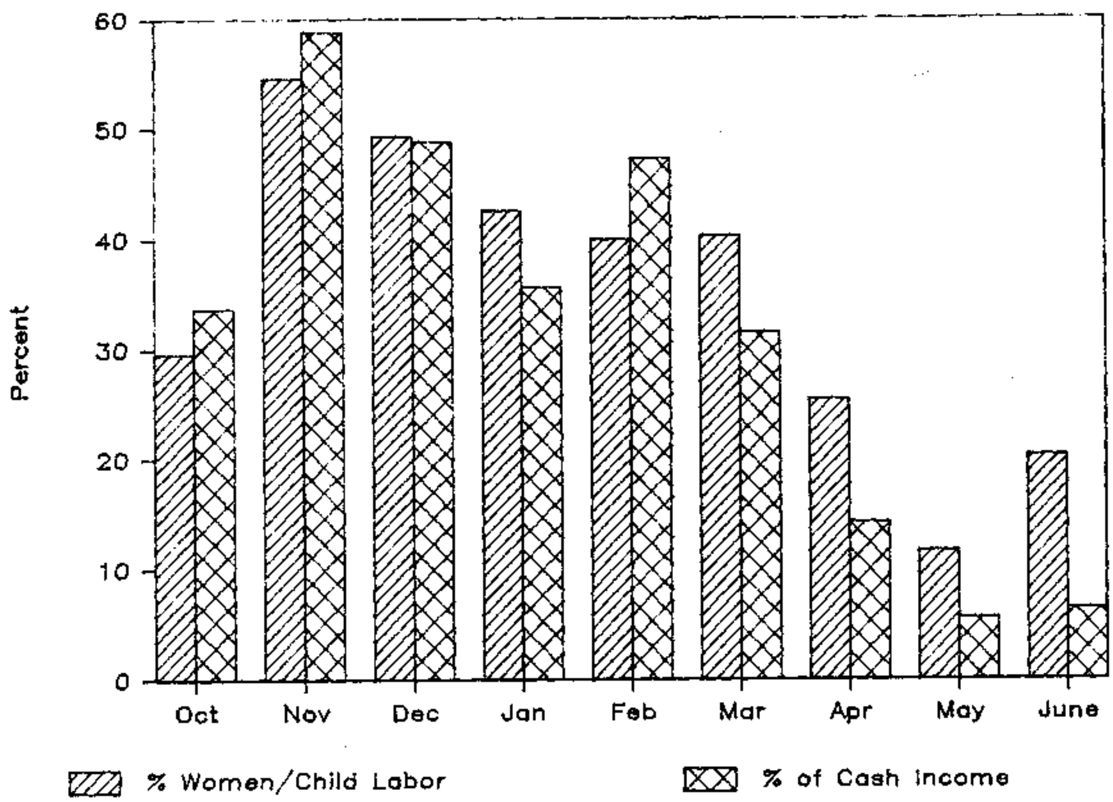

Figure 5.5. Proportional importance of babassu kernel extraction and sales to total female and child labor, and household cash income generation: all survey households: Oct., 1983 - June, 1984.

The economic rationale behind reduced labor allocation to babassu collection over time comes from the relationship between labor requirements and kernel production. Due to increasing scarcity, the real value of kernels peaked after the harvest.[12] Despite the relative price increase, however, the demands of the roça and sheer distance made it less and less justifiable for collectors to sally forth in search of

[12] A description of seasonal conditions affect on supply of kernels and industrial raw material pricing is provided in Chapter VIII.

babassu fruit. The marginal kernel output to labor exhibits typical diminishing returns, when corrected for harvest seasonality. As the harvest became more difficult toward the end of the season, the amount of work necessary to extract the same amount of kernel increased marginally. This relationship was tested statistically, using November to June data for the survey households,[13] with the following results:

KERNEL OUTPUT		INTERCEPT	HOURS KERNEL EXTRACTION	MONTH	r^2
Y	=	5.64	+ 0.443	- 0.812	0.974
SIGNIFICANCE:[14]			**	*	

Although the "month" variable (increasing from November = one to June = eight) is not strongly significant, its incorporation in the regression brought a substantial increase in explanatory power. Its sign is negative, as expected, reflecting the diminishing returns to labor as the end of the harvest season drew nearer.

According to most survey respondents, fruit collection does not begin in earnest again until September, when fruit that had ripened during the rainy season begin to drop. However, farmers told me that in some areas, particularly along streambanks in the cerrado and in many parts of the more humid cocais, fruit mature year-round. The slight upturn in

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[13] Kernel production rose to a peak in the month of November; thereafter, the harvest declined.

[14] * Rejects H_0 with 60 percent probability.
** Rejects H_0 with 95 percent probability.

babassu kernel production in June after completion of the rice harvest suggests that this activity continues at a low level throughout the months of July and August. Since some industries remain in operation and price series exist for these months, it appears that some earlier studies err in describing this activity as a purely seasonal one.

The relative importance of babassu kernel income is greater for the cerrado than for cocais survey households, although in absolute terms kernel production per household is nearly equivalent between regions (Table 5.4). This can be explained by the comparatively low productivity of roças and lower agricultural wages in the cerrado, as well as by the devastating after-effects of the prior year's drought. Survey households in the cerrado had total incomes averaging only slightly greater than half of those in the cocais, but babassu products provided over 46 percent of their cash incomes, whereas in the cocais, babassu sales contributed merely 22 percent.

The importance of babassu kernels as a source of income is also closely related to overall production assets and income from the range of sources. The relationship between babassu kernel income and total income, including both cash and non-cash sources,[15] is described in Figure 5.6. The

[15] Cash income for survey households includes a combination of cash wages, agricultural and babassu product sales, livestock sales, and retirement pensions or disability benefits. Noncash income includes all produce withdrawn from storage, livestock consumed from own stock, game animals and fish, and babassu products used for home consumption; all noncash consumption was valued at local market prices for

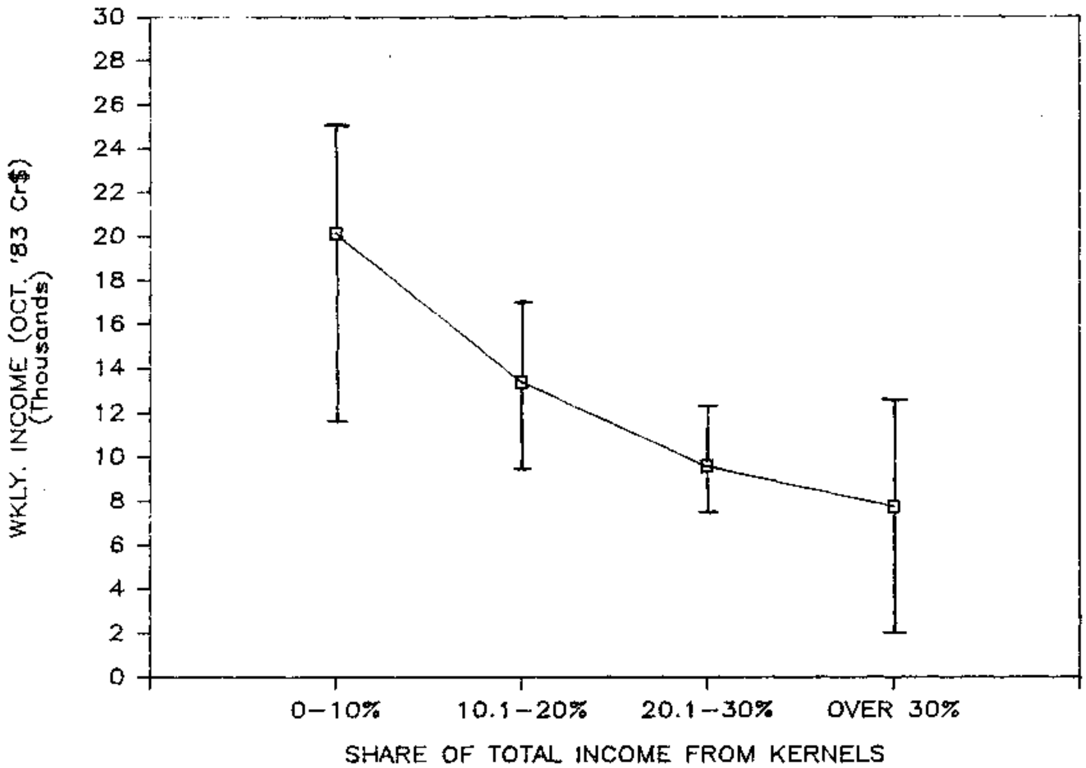

Figure 5.6. Mean and 95% confidence intervals for survey households' weekly incomes, by proportion due to cash sale of babassu kernels.

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survey data show that the importance of babassu kernel sales to overall income increases with relative poverty. Households were divided into four groups: those whose total incomes were accounted for by cash receipts from kernel sales of from zero to 10 percent, 10.1 - 20 percent, 20.1 - 30 percent, and over 30 percent. While there was some overlap in 95-percent confidence intervals for group income means, Figure 5.6 shows that household incomes declined steadily as the

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equivalent goods, where such prices exist.

Table 5.4. Average weekly income by source and study area, Lima Campos and Chapadinha, Maranhão: Oct., 1983 - June, 1984.

	STUDY AREA					
	Cerrado (n = 18)		Cocais (n = 24)		All Survey Households (n = 42)	
INCOME SOURCE	Cr$	%	Cr$	%	Cr$	%
Cash Income	5,209	68.3	8,802	59.1	7,149	61.2
Agricultural & Livestock	369	4.8	3,347	22.5	2,071	17.7
Babassu Kernel & Charcoal	2,418	31.7	1,937	13.0	2,143	18.3
Wages	1,605	21.1	1,665	11.2	1,640	14.0
Pensions & Remittances	817	10.7	1,653	11.1	1,295	11.1
Noncash	2,414	31.7	6,102	40.9	4,540	38.8
Agriculture, Livestock, Fish, and Game	1,907	25.0	5,719	38.4	4,086	35.0
Babassu Products	507	6.7	383	2.6	454	3.9
TOTAL INCOME	7,623	100.0	14,904	100.0	11,689	100.0
TOTAL BABASSU	2,925	38.4	2,320	15.6	2,597	22.2
TOTAL NONBABASSU	4,698	61.6	12,584	84.4	9,092	77.8

relative importance of babassu kernel sales to that income increased. This suggests that any change affecting the degree of access to palm groves, the share of fruit value going to collectors, or the form in which babassu fruit are sold will have welfare consequences of considerable significance for the poorest rural denizens of the region.

Differences in relative importance of babassu production were allied with other important features distinguishing the rural producers in this study along status grounds. Moradores were far and away worst off among survey households. Their average incomes from all sources were less than two-thirds those of both minifundia owner-operators and squatters in the sample (Table 5.5).[16] At the same time, the proportion of moradores' incomes derived from babassu kernel and charcoal sales was nearly one-quarter, as opposed to only about 11 percent for both minifundia owners and squatters. Moradores had cash crop and livestock sales averaging only about one-third of those of the other two groups. Babassu consequently was two to three times more important to moradores' overall cash incomes than it was to minifundia owners and squatters. On the other hand, squatters were less self-reliant on their own agricultural and livestock production than were minifundia operators, and derived over three times as much of their total

[16] One important reason for sample squatters' considerably better overall incomes when compared with moradores is the fact that all squatters in the sample reside in the Cocais survey area, while a disproportionately large number of Cerrado sample households are moradores. This, however, reflects actual conditions in the babassu zone as described in the previous chapters.

Table 5.5. Average weekly household income by tenure class, Lima Campos and Chapadinha, Maranhão: Oct., 1983 - June, 1984.

	LAND TENURE STATUS					
	Moradores (n = 25)		Squatters (n = 10)		Minifundia (n = 7)	
INCOME SOURCE	Cr$	%	Cr$	%	Cr$	%
Cash Income	5,877	62.1	9,312	64.2	8,321	54.4
Agricultural & Livestock	1,108	11.7	3,048	21.0	4,114	26.9
Babassu Kernel & Charcoal	2,348	24.8	1,570	10.8	1,761	11.5
Wages	2,099	22.2	1,455	10.0	507	3.3
Pensions & Remittances	322	3.4	3,239	22.3	1,939	12.7
Noncash	3,591	37.9	5,200	35.8	6,979	45.6
Agriculture, Livestock, Fish, and Game	3,113	32.9	4,827	33.3	6,499	42.5
Babassu Products	478	5.0	373	2.6	480	3.1
TOTAL INCOME	9,468	100.0	14,512	100.0	15,300	100.0
TOTAL BABASSU	2,826	29.8	1,943	13.4	2,241	14.6
TOTAL NONBABASSU	6,642	70.2	12,569	86.6	13,059	85.4

incomes from off-farm wage labor. Remittances from members living off the farm or pensions also contributed significantly to squatter households incomes.

These data suggest that relative well-being, on a cash and imputed production value basis, is strongly dependent on land tenure status among the survey households. While squatters are more autonomous than moradores, retaining more of their production rather than paying rent, they are seldom able to secure production credit and hence must sell more of their output than minifundia owners and must secure off-farm work to cover their cash outlays. The contribution of babassu to total cash requirements under such circumstances is not as great, but is of acknowledged importance to the squatters' overall strategy. Babassu kernel is also a source of income for owners of minifundia, most of whom rent some land to moradores, no matter how small their holdings. Babassu thus contributes working capital for other production activities while demanding little if any labor aside from that necessary to market the kernels produced by the moradores and sold through the landowner.

These data are supported by similar findings in the municipio of Bacabal (Anderson & Anderson, 1983), where residents' land "asset base" was found to be inversely related with their level of babassu kernel extraction. A given household's land assets were defined in the Andersons' study as the area of property they owned or held temporarily for production purposes. Of those whose land "holdings" were smaller than one ha., predominantly landless peasants, 63 percent reported daily or weekly fruit breaking. Of those whose holdings were between one and 100 ha. in size, a greater proportion reported breaking fruit on a weekly rather than daily basis, while 88 percent of those with landholdings over 100 ha. reported that they never break babassu fruit at all. Not only is frequency of babassu kernel extraction closely associated with poverty, but reliance on kernel sale as a source of income is generally considered demeaning. Women told me that they would prefer another means of livelihood if one were proferred but, apparently, society offers few options.

Babassu kernel income is primarily received by women and spent on items of immediate and critical importance to the household's survival. During the six-month period from October, 1983 to March, 1984 in which babassu kernel was proportionately most important as a source of cash income, over half of cash expenditures were made for basic foods (rice, beans, and cassava flour) and medicine (Figure 5.7). Suely Anderson accompanied five women as a participant-observer during a day's work breaking babassu fruit in the forest (Anderson & Anderson, 1983). On their arrival, the women all went immediately to the nearest store to purchase food and kerosene and settle debts owed the storekeeper, using the newly extracted kernels as a proxy for cash. As the harvest of annual crops commenced, households were able to spend less on basic foods (nine percent of total cash expenditures on average over the months of April, May, and June), but this was also the period when babassu was not as important a contributor to cash income (Figure 5.7). Nevertheless, during this latter period, babassu kernel income still contributed more than enough cash to cover basic food expenses.

Babassu has the function of a risk cushion in the event of crop failure. The availability of this source of income after a drought year (1982-83) was instrumental in enabling many landless families to remain in regional agriculture. Yet, their reliance on babassu to stave-off deprivation brings to light the vulnerability of peasant households.

Internal Weaknesses of Babassu Production Systems

Babassu agroforestry systems have evolved within an environment of extensive land use for annual crop production and grazing. Their low intensity of land use and failure to adopt risk-averting techniques make these systems internally fragile and leaves producers vulnerable to crop loss. This fragility is well exhibited by the results of the severe drought in 1982-83.

During the crop year beginning in July, 1982, both cocais and cerrado areas experienced moisture deficiencies (Figure 5.8).[17] Crop output was poor when compared with normal

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[17] In Bacabal, rains began late and ended early; total precipitation was only slightly better than half the average. In Caxias, the July to October land preparation period had better than usual rains, but the rainy season itself only lasted four months; total precipitation was less than two-thirds of the average in the Cerrado.

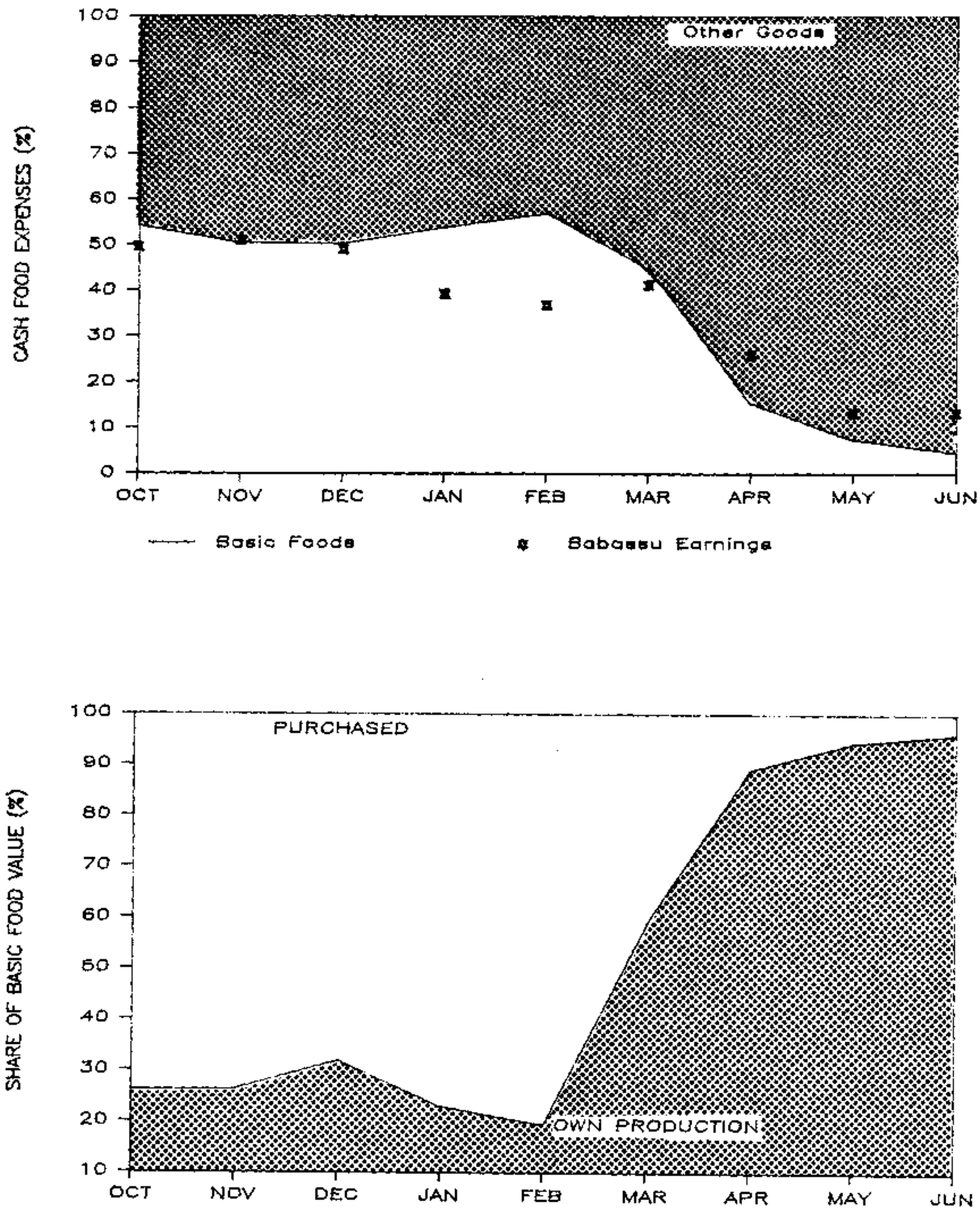

Figure 5.7. Composition of monthly household expenditures, and proportion of total food expenses covered by cash income from babassu kernel sales, all survey households: Oct., 1983 - June, 1984.

yields, particularly in the cerrado, where respondents reported yields 90 percent below average. Babassu provided a risk cushion, but, because of the low output of the prior crop year, was intensively harvested — the cushion only lasted a few months. The response was accelerated outmigration from areas hard-hit by the drought,[18] and intensified dependence on landowners and merchants for credit by those who remained.

In response to the drought, many cerrado producers planted their next crop in bottomlands, which were flooded by the next year's overwhelming April storms. This produced what became known as the "seca verde" or "green drought" (Veja, 1984). Flooding in combination with insufficient seed from the previous drought year made 1983-84 production nearly as poor as the prior year's. Thus, while the 1983-84 cycle would have appeared propitious in terms of overall rainfall, already debilitated peasants were further undermined, and migration continued.

Landowner paternalism and denial of tenure security are important reasons for peasant vulnerability and intrinsic weaknesses in babassu-related systems. The specific terms under which landless peasants are enabled to produce on landowners' property typically deny them the prospect of accumulating sufficient resources to improve their material

[18] Nearly 20 percent of survey households in the Cerrado abandoned their plots during the 1983-84 crop year. This is a biased sample since only those households which had assured us they would remain were included in the sampled population. It is probable that a greater proportion of peasant households were forced to depart.

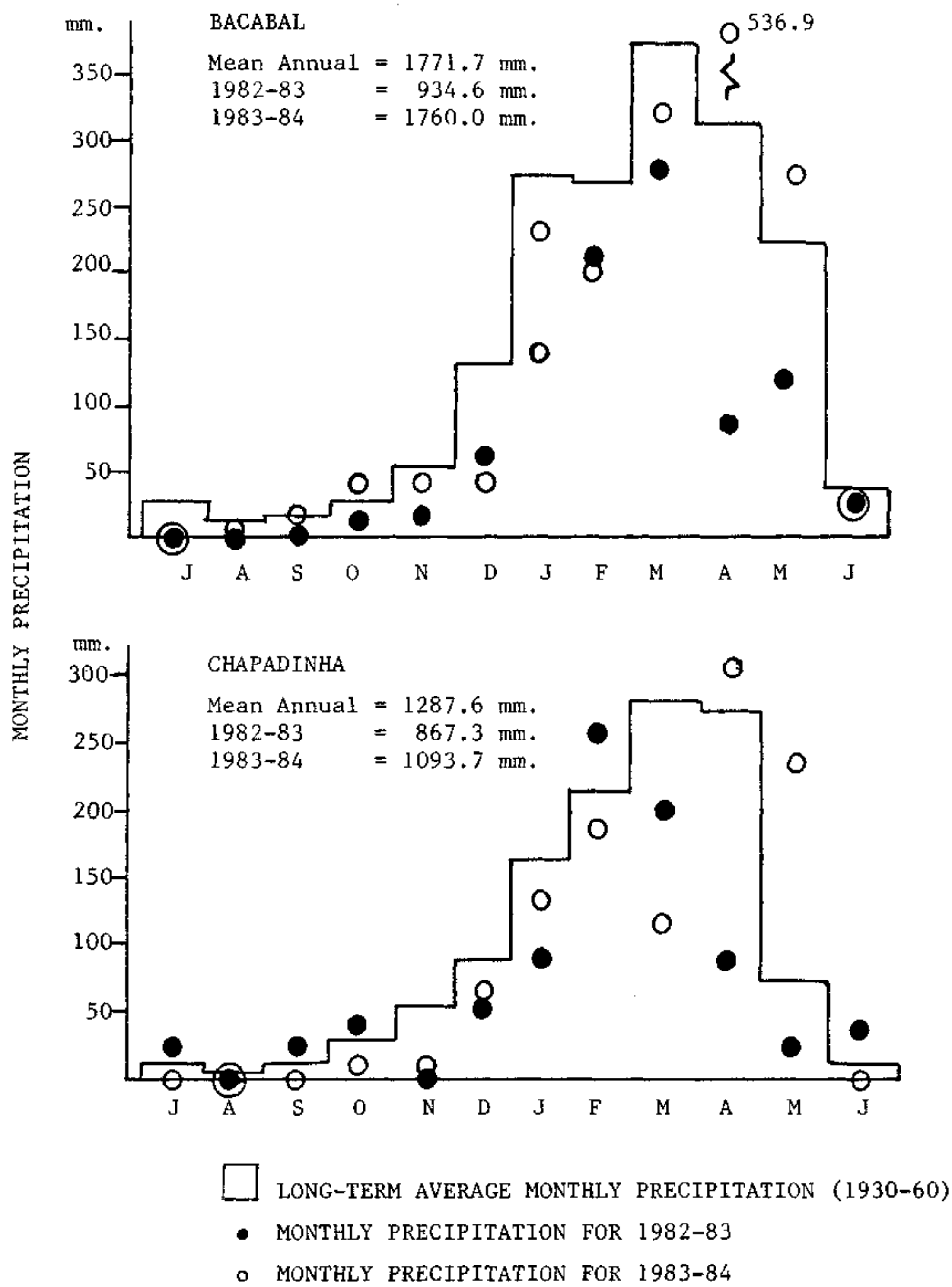

Figure 5.8. Precipitation in Bacabal and Caxias, Maranhão: long-term means and 1982 - 1984 (data from Instituto de Pesquisas Atmosféricas).

conditions. Frequently, there are specific prohibitions against moradores keeping cattle or other livestock on the property. Many landowners in Maranhão earn pasturage fees that averaged US$ 2.75 per animal-month in 1983 from peasants who have been able to accumulate a small herd but lack land for grazing (Fundação Getúlio Vargas, 1983). In addition, since agricultural plots are only ceded temporarily, and their tenure is insecure at best, peasants have no incentive to maintain soil fertility or to irrigate cropland.[19] Moradores are typically disallowed from planting perennial crops, as these constitute "improvements" which a landowner would be required to reimburse under the federal land statute, should the morador family leave or be expelled. Instead, babassu stands provide the "subsidy from nature" that maintains the fragile low-level equilibrium in peasant production.

There are many who consider babassu to be the "cause" of Maranhão's poverty and near absence of agricultural dynamism. They see babassu's availability as a rationale for peasants to avoid hard work. Manual fruit breaking is perceived by men to be a shameful activity; women told me they would rather do anything other than this were there some option. But the society offers few other options.

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[19] Federal emergency assistance for the drought-stricken population typically involves investment in water storage facilities. The terms of the federal assistance program require that peasants who build them have access to the water storage in future droughts. In practice, however, the facilities are built on private estates, and benefit the large landowner rather than the peasants in most cases.

In other parts of Latin America, landless and near-landless peasants are forced to rely on wage labor for a significant proportion of their overall incomes (de Janvry, 1981; Deere and Wasserstrom, 1982). Many small farmers in the survey areas were no exception, but overall, wage labor contributed only 14 percent **of total** income from all sources (Table 5.4). Wages were essential to stave-off deprivation induced by drought in **the** cerrado after the poor crop year of 1982-83. There, government-sponsored public works programs employed many of the landless at about one-quarter the regional minimum wage until the rains returned in January. Despite this source of employment, cerrado residents as well as those in the cocais relied on babassu kernel sales for a larger share of their overall incomes than wage labor. Incomes in the babassu zone are thus to some extent stabilized and bouoyed by the subsidy from nature derived from kernel sales.

Subsistence Uses of Babassu Fruit

In addition to the importance of babassu leaf biomass and cash income from kernel sales, babassu palms provide a broad range of subsistence products. These include charcoal, feeds, edible oil, and a wide variety of basketry and construction materials. Table 5.6. shows that most rural households interviewed make use of these products. The principal subsistence uses of babassu were included as income in small farm household surveys. The value of charcoal, kernels, and leaves

Table 5.6. Proportion of rural households reporting use of babassu products, by survey area and product.

(Percent of households)

AREA/PRODUCT	Milk	Oil	Charcoal	Basketry	Thatch	Palmito
Chapadinha n = 98	89	91	96	90	86	42
Lima Campos n = 64	70	66	92	83	94	8
São Bento n = 57	72	74	49	72	76	16
Average n = 219	79	79	83	83	86	25

used by survey households was imputed.[20] Their contribution was small but significant to overall welfare, constituting over 10 percent of income accounted for by goods used for subsistence (Table 5.4.). Babassu fruit in particular are essential as a principal source of rural fuels and edible oils.

Whereas most extracted kernels are sold immediately, a small proportion, averaging five percent of total kernels extracted by survey households, or about 0.7 kg. weekly per

[20] The value of these goods was imputed at the going local market price for those items of regular market exchange (charcoal, kernels, baskets). Other values were imputed by asking what residents would pay if they should be unable to collect them locally (e.g., leaves used as feed, mats, fans, etc.). Quantities of the products used were ascertained through farm records maintained by survey households detailing the amount of kernels used for milk and oil or sold, the volume of charcoal produced and sold, and the amount of leaves harvested and used for making baskets.

household, is used domestically.[21] Ripe kernels are pounded in a mortar until well crushed, mixed with water, and filtered to produce babassu milk. This milk is used primarily in stewing fish, game, fowl, and goat meat. Alternatively, people consume the milk directly or mixed with coffee. The less fatty milk from immature kernels is sometimes made into porridge for infants. This milk's unbalanced amino acid composition (Figure 5.9) and relatively low mineral content make it unsuitable as a substitute for human or cow milk; however, kernels eaten as a snack, kernel milk and residues serve as important dietary supplements for rural families and farm animals, and there is some interest in the potential for expanding these benefits (Governo do Estado do Maranhão, 1973).

People sometimes remove unripe fruits from the bunch to extract the watery endosperm, which is consumed as a beverage or used as a remedy for sties and bleeding. Kernels are also used domestically to produce oil for cooking, soapmaking, and burning in lamps. To make oil, people roast the kernels lightly and mash them in a mortar. Water is then added and the mixture is cooked to release the oil, which is skimmed off the surface. In some parts of the babassu region, a cottage oil industry has arisen, using small power-driven mills and oil expellers. The quality of this oil for edible

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21 These figures exclude consumption of kernels as a snack, which could not be accurately measured. Consequently, both domestic use and total production of babassu kernels are underestimated.

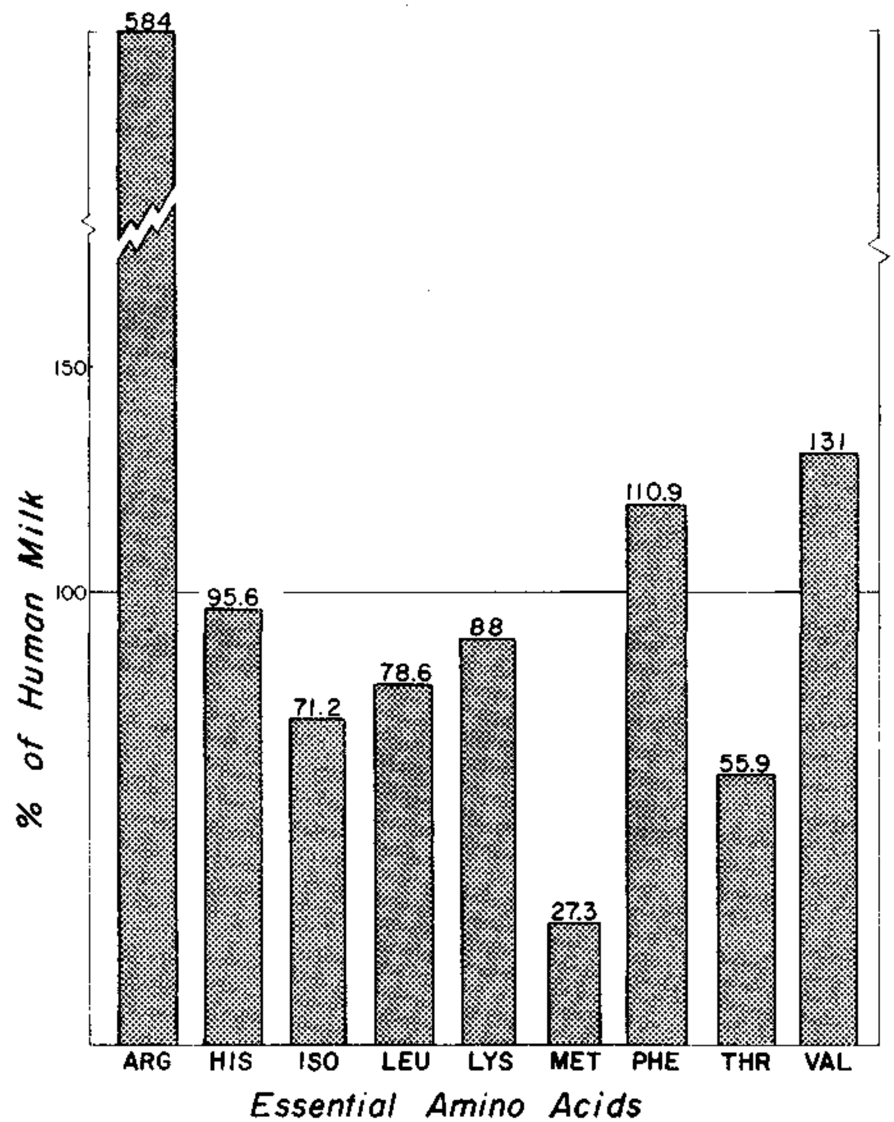

Figure 5.9. Comparison of babassu kernel milk amino acid content with that of mother's milk (adapted from Governo do Estado do Maranhão, 1973).

purposes is higher than unrefined industrial babassu oil, due to the lower rancidity of kernels shortly after extraction in comparison to those stored for industrial crushing. Babassu kernel oil is considerably higher in saturated acids than other oilseeds such as soybeans, which makes babassu oil less easily digested than soybean oil. Nevertheless, babassu oil produced in cottage industries finds a ready though restricted market in urban areas of the region, usually at prices well above commercial oil or margarine made from other oilseeds.

During the latter part of the fruit harvest season, many fruit have been infested by larvae of a beetle which resides inpalm crowns, locally called "bicho do coco", which lay their eggs on fallen fruit. The larvae burrow their way through the fruit's germination canals until they reach the kernels, which they consume. When a well-fed larva (called "gongo") is found in a broken fruit, people toast it on a spit and eat it. Fried gongo have a taste greatly resembling that of bacon.[22] Larval predation does not result in serious loss in kernel production; Anderson (1983) found that although 70 percent of fruit contained larvae 40 days after falling from the bunch, less than 40 percent of the kernel chambers in each fruit were occupied by larvae after the same period, following which predation declined. However, the risk that larvae may have consumed kernels which could be sold makes it desirable to harvest fruit shortly after they fall. During the first 10

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[22] Rather than rely on hearsay, the author confirms that he did indeed partake of roasted gongo, and found it a tempting morsel indeed!

days after dropping from the bunch, there was very little predation, but from the tenth to the twentieth days, 20 percent of the kernels and 40 percent of the fruit were attacked (Anderson, 1983). This is another factor affecting fruit breaking productivity in terms of kernel output, as described above. In some areas, collectors cut bunches from the tree, but here one runs the risk of kernel immaturity and greater difficulty in extraction.

The woody endocarp that encloses the kernels also has an important role in subsistence economies as a source of fuel. Most households produce charcoal from these husks on a weekly or biweekly basis. After breaking fruits, people leave the husks in piles for drying and subsequent carbonization. Kindling is initially ignited in a round hole (caeira), approximately one m. in diameter and depth, into which the husks are gradually pushed. Once all the husks are well burned water is sprinkled over them to slow combustion, and the caeira is covered with palm leaves and sand (Figure 5.10). After allowing carbonization to continue overnight, people remove the charcoal and store it in baskets made from babassu leaves.

Households in the survey used an average of 10 kg. of this charcoal each week for cooking. Babassu charcoal is the most frequently used cooking fuel encountered among families interviewed. The charcoal produces a smokeless, long-lasting fire that is appropriate for local clay-covered stoves, which are usually located indoors. During the latter part of the days after dropping from the bunch, there was very little predation, but from the tenth to the twentieth days, 20 percent of the kernels and 40 percent of the fruit were attacked (Anderson, 1983). This is another factor affecting fruit breaking productivity in terms of kernel output, as described above. In some areas, collectors cut bunches from the tree, but here one runs the risk of kernel immaturity and greater difficulty in extraction.

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Figure 5.10. Burning of babassu husks to manufacture charcoal.

rainy season, when babassu fruit breaking was not as frequent, people searched for husks left by breakers in the forest to make charcoal, but were in general forced to rely more on fuelwood and charcoal made of wood from other trees. Though babassu charcoal is increasingly entering markets for industrial fuels, only 25 percent of the households interviewed reported that they sell charcoal, and 13 percent of total charcoal production by survey households was sold in 1983-84, most of this by a small number of producers.

In comparison with kernel breaking for sale, use of babassu charcoal for cooking is not significantly status-related. The data from Bacabal suggest that charcoal use asa cooking fuel is somewhat associated with control over land; the Andersons' data show an inverse relation between size of land holding and the proportion of households using this fuel (Anderson & Anderson, 1983). However, I failed to find a similar correlation between land tenure status groups and charcoal use or sale. All the households in both the cocais and cerrado study areas relied equally on charcoal for fuel requirements, but much less so in the baixada communities visited during the first three months of the survey. This may have something to do with the relative plentifulness of fuelwood, but also appears to be associated with fuel preferences: baixada respondents said that babassu charcoal burned holes in their pots.

Access to alternative fuel sources is limited in some areas by both the cost of gas stoves and the scarcity of wood fuels. Babassu charcoal makes a substantial contribution to real rural income and protects forests from excessive fuelwood harvesting, a significant problem in many regions of the world (Eckholm, 1975). A 1970 survey found that between 92.7 - 98.3 percent of all Northeast Brazilian rural households use fuelwood and charcoal for home cooking fuel (Brown, 1980). If each household in our survey used fuelwood instead of babassu as a source of charcoal, they would each need to harvest about 3.2 cubic meters (m^3) of fuelwood annually. This would necessitate access to the equivalent of three ha. in the cocais and six ha. in the cerrado of climatically equivalent forest dominated by timber trees under sustained yield after removal of the volume suitable for industrial or building purposes.[23] These figures actually understate the case, since in

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[23] This estimate is based on a conversion rate of 170 kg. charcoal per cubic meter of undifferentiated tropical hardwoods (FAO Forestry Dept., 1983a, Annex IIIb), and an approximation of survey household's fuel requirements at 500 kg. per year based on actual babassu charcoal consumption reported during 1983-84. Fuelwood production levels were obtained from recent estimates (FAO Forestry Dept., 1983b) for Latin American savannas with trees used as a proxy for Cerrado conditions (30 m^3 per ha. standing volume; 0.5m^3 fuelwood extractable per annum after roundwood removal under sustained yield) and forest fallows used as a proxy for nonbabassu forests in areas climatically resembling the Cocais (1.0 m^3 per ha. extractable fuelwood annually; variable standing volumes). This estimate is quite conservative. Surveys for the Matriz de Energia Brasileira conducted in 1970 showed average per household rural fuelwood consumption in the Brazilian Northeast to be on the order of 14.6 m^3 per annum (Brown, 1980), which would require from 15 to 30 ha. of secondary forest per household based on the sustained yield analysis above. These requirements approximate those obtained from census data on fuelwood production in Maranhão, which in 1980 averaged 1.9 m^3 per capita for the state as a whole (IBGE, 1984b), and may be assumed to be biased downward due to the importance of babassu charcoal for fuel in rural as well as urban areas.

dense babassu forests of the cocais, the palm represents as much as two-thirds of all trees (Anderson, 1983), so there is much less fuelwood to draw upon than in successional forests lacking babassu palms.

In contrast, about 300 kg. of charcoal can be produced from the husks harvested from a dense one ha. native stand of babassu palms. The average household in our survey, using about 500 kg. of charcoal yearly, would thus require access to about 1.7 ha. of babassu to provide the household with its annual charcoal requirements. The value of this charcoal at local market prices was only about two US cents per kg. at the height of the babassu fruit harvest. This price, however, understates its opportunity cost, for the value of available alternatives such as fuelwood, kerosene, or liquid petroleum (LPG) gas would be considerably higher.[24]

Charcoal is not the only use to which peasant households put babassu husks. After fruits are collected and dried, they are beaten with a club to loosen the fibrous epicarp and pulverize the dried mesocarp within. The latter falls to the ground where it is quickly set upon by pigs and fowl. Alternatively, people leave broken babassu husks in piles to be fed upon by animals prior to the production of charcoal. The mesocarp's high starch content (60 percent) provides an excellent source of carbohydrate that is considered especially appropriate for pork fattening. Among rural families through-

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[24] **The issue of opportunity costs for alternatives to babassu subsistence products is examined in greater depth in Chapter VIII.**

out the babassu zone, mesocarp meal is used as a substitute for cassava flour during times of scarcity. People also mix unroasted mesocarp flour with water to treat gastrointestinal complaints, or simply as a beverage which closely resembles chocolate. This powder is encountered in natural medicine stores throughout Northeast Brazil, where it is marketed as a cure for a variety of ailments.

Besides the domesticated animals they feed with babassu mesocarp, rural households also depend on hunting and fishing to supply important sources of protein. The majority of households interviewed fished frequently during the rainy season, and 14 percent of the total value of animal foods consumed during the survey consisted of fish and game meat. People also use babassu kernel residues and larvae found in fruit cavities as bait for fishing and trapping animals. Large rodents such as pacas and agoutis feed on the starchy fruit mesocarp. They abound in the palm forest that nourishes them, and serve as a source of game meat for rural families (Smith, 1974). In turn, the rodents help to stimulate the propagation of the palm stands by transporting fruit, a process also aided by water runoff (Anderson, 1983).

Uses of Babassu Through the Palm's Life Cycle

Removal of the mesocarp by rodents acts to stimulate germination in babassu, which under normal conditions requires about three months (Anderson, 1983). The rate of growth of babassu palms is strongly influenced by competition and

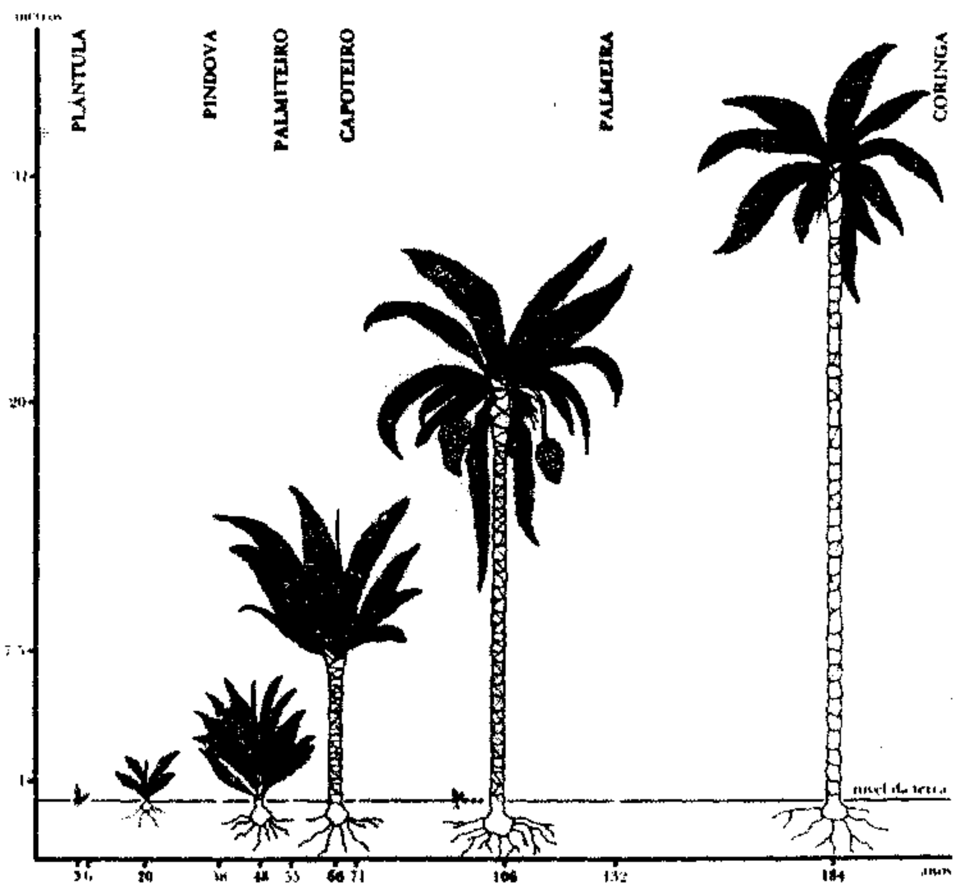

Figure 5.11. Babassu palm growth stages (based on data in Anderson, 1983).

shade. On a primary forest site, a seedling of babassu required an average of seven years to produce its first divided leaf, and another 42 years to initiate vertical growth of the stem (Anderson, 1983; Figure 5.11). Under unshaded or otherwise more favorable conditions, however, farmers testify that babassu palms grow to maturity 10 to 20 years after they emerge as seedlings.

Palms that have passed the seedling stage, but whose stems have not yet emerged, are referred to as pindovas. Extremely high densities of pindovas occur on sites where babassu predominates, with one count of over 6,000 per ha. (Anderson, 1983), or one pindova every 1.7 square meters. Farmers cutpindova leaves and collect them in bundles to be fed to animals in times of poor pasture growth. Babassu leaves are not preferred as forages by grazing animals, probably because their fiber content makes them less palatable than other vegetation. However, palm leaves appear to contain nutritious enough material to supplement other feeds at these critical times.

Leaves are harvested not only from pindovas but from palms in subsequent stages as well. Leaf harvesting does not appear to impede growth of palms or production of fruits permanently, as long as it is carried out at sufficiently wide intervals, and the newer leaves are retained to assist in the palm's subsequent recovery. Harvesting of these younger and more flexible leaves, which people prefer for the production of baskets or mats, may be injurious to the vigor and productivity of the tree. Rural families cut leaves (which may total up to 25 per mature palm, from five to nine m. in length) for construction or reinforcement of their dwellings, and for building fences, frames for vegetable planters, and other items. Babassu thatch is by far the most frequently used roofing material in the region (Table 5.6). Fibers from the rachis or leaf spine are used to make bird cages, twine, and torches.

A palm that survives to the point at which a stem emerges is called palmiteiro. People sometimes kill these palms for extraction of the palm heart (palmito), which is used as food for domesticated animals and people. The practice of cutting babassu for palmito is limited to some extent by state laws and local taboos that prohibit the cutting of palms.[25] Despite this protection, palmiteiros are subject to high mortality on sites where cutting and burning are frequent, due to the increased susceptibility of the emerging palm heart to damage. As a result, the density of palms that survive to subsequent stages tends to be comparatively reduced.

After stem emergence and prior to initiation of flowering, the palm is called capoteiro. Flowering usually begins when the palm attains a height of four to eight meters. Those mature palms that produce exclusively male flowers (termed macho) are preferentially thinned during land preparation, as they are unlikely to bear fruit. In some areas, the stems and

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[25] The legal framework for babassu palm conservation, and landowners' policies regarding thinning of palms by moradores for roça preparation or palmito, are described in Chapter VI.

detritus are piled in windrows and upon decomposition provide a fertile substrate for plantings of maize. Babassu stems are also used for building bridges and foundations. People often hollow out the stump after cutting to collect the sap, which ferments, producing an alcoholic beverage known as palm wine. The stem is sometimes left where it falls to attract beetle larvae, which are later gathered and cooked, providing an important source of protein.

Formerly productive palms that no longer bear fruit are known as _coringas_. When these palms finally fall, rural families use their decomposed stems as a mulch and planting medium for vegetable gardens and raised planters. Potting soil of decayed babassu palm stems is also sold in urban areas.

Finally, babassu's economic importance has earned it ritual significance in rural life. The _Dança do Coco_ (Babassu Dance) is performed each year during the month-long celebrations leading up to St. John's Day on June 24th. Girls wearing traditional dresses and carrying small baskets like those used for collecting kernels circle around the boys while making motions of breaking fruit with small wooden hatchets. Around the time when babassu fruit begin to fall, several municipios hold an annual babassu party in a hall decorated with ripe fruit bunches and palm leaves.

Conclusions; The Importance of Babassu to the Peasantry

The data presented in this chapter have shown that babassu palms and the multiple products derived from them constitute essential contributors to peasant livelihood in cerrado and cocais agricultural systems of Maranhão. Babassu palms generate cash income during the period preceding annual crop harvest by women and children when their labor is not critical to agricultural production. In addition, the palms provide the major source of rural cooking fuel and a range of food, feed, and fiber goods which enable some peasants to retain a measure of self-sufficiency while protecting resource productivity.

The choice to engage in babassu collection is dependent on a range of conditions affecting individual households' economic vitality and prospects for future improvement. The most critical of these conditions is that of land resource endowment and tenure security. In this chapter, we have seen that the importance of babassu kernel sales to overall household income increases as the total income from all sources declines. Households that own or occupy land as squatters are considerably better off than the landless moradores who represent the bulk of the rural population and supply the majority of marketed babassu kernel. Households residing in the agriculturally less productive cerrado region are, regardless of tenure status, less well off than those in the cocais, and babassu contributes a commensurately greater share of their overall incomes. It is little wonder, then, that babassu stands in the cerrado are more fully exploited than those in the cocais.

The decision to engage in babassu collection as a constituent of a small farm production strategy is strongly guided by the conditions of production and not by individual choice. The analysis of small farmers' strategies presented in this chapter lends support to the hypothesis that the relative importance of babassu is influenced by peasant property rights as well as by agricultural productivity. If the peasant family could grow enough food to cover its own requirements and meet nonfood needs with sufficient surplus, babassu extraction would probably be reduced in its proportional contribution to income. This leads us to consider how change in the enterprise structures within which small farmers produce might constrain their economic options.

The peasants of the babassu zone are subject to pressures from a variety of sources which make their potential to achieve autonomy tenuous at best. Chief among these are threats to their already insecure tenure status and impairment in rights to collect and utilize babassu palm products. The previous chapter has illustrated how peasants have been affected with respect to their economic options by alterations in enterprise structure and the emergence of new product markets in the cerrado areas surrounding Caxias, Maranhão. The next chapter details the outcomes of peasant vulnerability to the forces of agrarian change to which they are subject in the cocais and expanding Amazon frontier.

CHAPTER VI

LANDOWNERS' DECISIONS AND THE NON-COMMONS TRAGEDY

Just as babassu is functional for the landless and near-landless producers described in the previous chapter, landowners have traditionally retained the palms as an element of their multiple enterprise operations. With agrarian change, land uses have arisen that conflict with babassu forests and with peasants' access to those that remain. This chapter compares land use conditions in the cerrado with those in the cocais as they influence the babassu economy. The transitional character of the landscape in the babassu zone makes it difficult to offer conclusive distinctions. Nevertheless, landowners of the cocais and cerrado survey areas differed markedly in their perception of the palms' importance to the future of their enterprises.

Since the emergence of a regional oil industry based on babassu kernels in the 1960s, the importance of kernel production to agricultural enterprises was stimulated as buyers scoured the nearly inaccessible backlands for kernel. This importance was particularly notable in the cerrado areas of Maranhão, where agro-ecological conditions do not favor intensive livestock or crop production. Caxias landowners interviewed by Nicholls and Paiva in 1973 valued land abundantly endowed with babassu palms as much as double that lacking palm stands (Nicholls, unpublished data). It is likely that this not only reflects the association of babassu with the better soils (Moran, 1981), but also the economic importance of the palms.

While some landowners interviewed during my study in 1983 and 1984 were still reverent toward babassu, the basis for land valuation had changed. Improved pastures were now valued higher than stands of palms. This chapter discusses some of the factors which make retention of babassu desirable for some, and the rationale for a growing trend toward palm eradication. This chapter also explores the dimensions of peasant vulnerability to change. The effects of landowners' decisions on the peasantry depend on the options available to peasants for shifting their income-earning activities to suit the emerging agrarian economy.

Land Use Change; Cerrado and Cocais Enterprises Compared

After the decline of the plantation economy in the late Nineteenth Century, babassu zone agricultural enterprises operated primarily as integrated production/consumption units having a low level of interchange with markets. Landowners' livestock enterprises on extensive range in the cerrado generated small quantities of beef and hides for market, which supplemented marketing of surplus grain and later in-kind rents in exchange for goods sold out of farm stores. This situation continued until the mid-Twentieth Century. With population growth stimulated by migration from the drought-stricken Northeast in the 1950s and 1960s (see Chapter III), urban markets in the babassu zone expanded.

Besides the influx of many peasant families migrating in search of unoccupied land, those of more means from other Northeast states flocked to the fertile valleys of Maranhão to establish small and medium-sized farms. Road construction and paving opened formerly inaccessible areas to trade, which boosted rural land values. Where land titles did not exist, the state facilitated occupation of frontier lands by offering property concessions to those demonstrating financial backing and the right connections, regardless of whether state lands were already occupied by squatters (Tendler, 1980; Wagner, 1981a).

Survey research on agricultural enterprises for this study focused on the areas selected for intensive study of peasant farms described in Chapter V, but also included farms of Caxias and the western frontier of Maranhão. The 21 operations for which data were obtained comprise a cross-section of the enterprises now occupying over 80 percent of agricultural land in the babassu zone (IBGE, 1984a). These were categorized in Chapter IV as latifundia, medium-sized family farms, and modern agribusinesses (Table 4.2). The survey properties are privately owned by individuals and in two cases by corporations.

In both regions an effort was made to secure a range in farm types and sizes reflecting the variation common to the region. The privately-owned properties studied range in total size from 75 to 16,000 ha.; those in the cerrado were on average considerably larger than those in the cocais (2,885 ha. versus 806 ha.). In the cerrado, most of the properties had been inherited by their present owners, with the exception of a few cases where long-term residents had transferred property to members of their immediate families. Their properties had been legally titled for some time, often over 50 years. Only one property studied in the cerrado was owned by an immigrant from outside the babassu zone. Despite his immigrant status, this person had resided in the region since 1960 after leaving his native Ceará, and had developed strong rapport and even a political following in his adopted community of Chapadinha.

In contrast, of the 10 cocais properties studied, seven had been purchased by their present owners in 1971 or later, and the majority of the farmers interviewed were immigrants from other parts of the Northeast. Most had expanded their total landholdings since the initial purchase; this expansion averaged on the order of an 80 percent increment over initial holdings. While estate division was a far more conspicuous characteristic of cerrado properties, only one of the cocais properties had been divided by sale or inheritance. Large properties in the cocais had typically expanded by the addition of entire farms to the owner's holdings, and rarely by purchase of adjoining parcels.[1] In many cases documented

[1] Purchase of large blocks of land is considerably less complex than negotiating with a multiplicity of titled owners and squatters. On the other hand, where such negotiations are necessary, they are frequently accompanied by threatened or actual violence, which tends to give the edge to the buyer who wields force. Violence committed against peasant communities has been carefully chronicled in the case of Maranhão by

in the literature (Wagner, 1981a; Tendler, 1980), lands incorporated within expanding farms at the Amazon frontier were previously operated by squatters, who relinquished their nominal rights to usucapiāo in exchange for cash instead of attempting the usually futile process of adjudicating their claims to undemarcated common land.

At the time of transfer to their present operators, the principal source of farm income of the property-owners surveyed in the cerrado was rent from and trade with moradores; a secondary source was livestock. Land use at the time of property transfer was, in the cerrado properties, overwhelmingly dominated by extensive grazing and forestland, with cropland annually occupying from less than one to about 15 percent of each property's area. Planted pastures were extremely limited as a component of land use. The low intensity of cerrado land use is justified by the low productivity of the resource base. Given the dominant technology and poor soil fertility, long fallows on scarce arable land are essential, and livestock cannot be sustained on less than five ha. of native pasture per animal unit.

Cerrado cattle and small livestock such as goats and sheep are grazed freely on unfenced range to enable them "to reach water and shade when necessary, to allow access to different grazing as each type of cerrado [vegetation] becomes

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Wagner (1981b). While squatters have sometimes been successful in organizing with the help of Church groups to repel unjust property claims, the peasants are more generally powerless against the economic and political might of land speculators.

palatable, and to enable cattle to follow the nutritious, succulent sprouts appearing after the frequent but irregular fires" (Eiten and Goodland, 1979:295). Fencing under this system is used more to protect crops from animals than to manage rangelands. The overall composition of surveyed cerrado properties' land use had changed little since the current owners took control, except as described earlier for the case of Caxias and neighboring municipios in the more fertile portions of the Itapecuru and Parnaiba river valleys.

In contrast, the cocais, foci of more recent settlement, demonstrate substantial shifts in overall agricultural land use. The new owners of these properties planted improved grasses at an accelerating rate during the 1970s. The percentage of area of the cocais properties covered with pasture increased from an average of 26 percent at the time of their most recent transfer (most occurring since 1971), to 64 percent by 1984.

The trend toward pasture conversion among survey farms is echoed by the census figures for agricultural land use in the Mearim micro-region, where most of the cocais survey properties were located. In the Mearim, the area in pastures increased at an annual rate of nearly five percent between 1975 and 1980 from 40 to almost 60 percent of total classified agricultural land (Table 6.1). To be sure, cerrado farmers also planted pastures during this period, when improved grasses increased from three percent to over seven percent of agricultural land in the cerrado microregions. Yet, the total

Table 6.1. Land use in the Mearim and Itapecuru/Alto Munim microregions: 1975 and 1980 (IBGE, 1979; 1984a).

LAND USE	MEARIM (Cocais) 1975	MEARIM (Cocais) 1980	ITAPECURU/ALTO MUNIM (Cerrado) 1975	ITAPECURU/ALTO MUNIM (Cerrado) 1980
	Percent of Area			
Crops	14.6	16.4	10.5	14.2
Fallow + Un-used Arable	36.9	18.1	45.5	43.7
Planted Pasture	32.1	44.4	2.9	7.3
Native Pasture	8.1	14.0	18.3	14.3
Forests & Other	8.3	7.1	18.9	20.5
Total Classified	100.0	100.0	100.0	100.0
Area (000 ha.)	863.4	784.3	1,817.4	1,834.5

area covered with native and improved pastures stayed nearly equivalent to its 1975 area, suggesting that part of the planting was done on land previously classified as native pasture.

Coinciding with the expansion of cocais farmland devoted to pasture was a stabilization or reduction in the number of morador households and in the importance of annual crop enterprises to overall operations. Cattle ranching alone is a very low absorber of labor. Many of the more recently established cocais farms were initiated with no resident farming households, and few landowners allocated property area to crop production on their own account. The symbiosis on traditional cerrado latifundia between peasant production and labor they provided for landowners' livestock and other enterprises (Figure 4.2) never existed in these newer operations in the cocais.

Maintenance of palm and soil productivity in agricultural systems of the babassu zone relies upon a shifting cultivation pattern having long fallow cycles. Population growth relative to land available for shifting cultivation is thus likely to reduce the efficiency and productivity of these systems. The logical outcome of pasture expansion in the cocais region is a reduction in the amount of arable land accessible to shifting cultivators. An examination of the relationship between land in annual crops and fallowed or otherwise unused productive land in the cocais reveals a rapid decline in the potential fallow cycles. In 1975, the potential fallow period was 3.5 years in the Mearim micro-region; by 1980, it had been reduced to 2.1 years.[2]

A decline in fallow cycles would have the ultimate effect of restricting babassu-related income. The shortened fallow cycle leaves insufficient time for babassu leaf recovery or growth of woody understory vegetation. In order to obtain sufficient biomass for the annual burn, peasant farmers must now cut babassu palms as well as other secondary species. This reduces the benefits to be derived from the palm during

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[2] Based on data used in Figure 6.1. The potential fallow period is the area in annual crops divided into the area in annual crops plus the area in fallow.

the fallow cycle. Peasants who depend on babassu for an important share of their incomes are thus thrust upon areas beyond the properties where they reside and grow annual crops in order to gather fruits. But, in doing so, they come into conflict with the new rural aristocracy, who have enclosed their properties against such incursions. In the next section, the characteristics of cattle ranching in the babassu zone are detailed to discern those factors which make babassu more or less desirable as a land use element. These factors are also crucial for maintenance or change in the peasants' access rights to palms.

Clearcutting versus Retention of Babassu in Pastures

Pastures are not exclusive land uses on most farms in the cocais; rather, grasses are planted under palms as a silvi-pastoral combination (Figure 6.1). The economic and environmental characteristics of this palm-pasture system are examined in this section. This is done with reference, first, to the economy of livestock production as practiced in the region. Next, the performance of palms in pastures is compared with that of palms in native stands. Finally, the interaction between the livestock and babassu enterprises is discussed in physical and economic terms.

Figure 6.1. Babassu palms over pasture in Maranhão (photo by J. Alves).

The Livestock Enterprise

The pasture grass planted on the majority of the region's ranches is known as _capim jaraguá_ or _lageado_ (_Hyperrhania rufa_), an African grass adapted to seasonally moist regions and poor soils. Cattle are grazed rotationally on this improved pasture. Ranchers frequently also plant small areas in forages such as elephant grass and cane, to be chopped and fed during the dry season. Cattle also are given a mix of 50-50 mineral salt and rock salt. Supplementary rations such as cottonseed cake and cassava chips are fed to milk cows during the dry season. Cattle receive medication against worms, rabies, foot and mouth disease, and afitosa.

Cattle are herded by cowboys who in the cerrado receive as payment one calf in every four they rear. In the cocais, cowboys receive a salary of one minimum wage, or receive a lower wage but are compensated with milk from the animals they raise, use of pasture for their own animals, land for crop production and, in some cases, right to harvest the ranches' babassu.

Pasture management involves twice-annual weed cutting and occasional burning and reseeding when weed infestation grows particularly severe. Some landowners are now paying for this work with rights to the babassu on the site weeded. Temporary labor is also required for repair and upgrading of fencing. Average annual pasture and herd maintenance costs per ha. are shown in Table 6.2, assuming a stocking rate equivalent to 100

Table 6.2. Livestock maintenance costs, herd of 100 adult animal-equivalents on 200 ha. of planted pasture.

COST ELEMENT	PER HA. COST (US$)[a]	
Mineral and rock salt (50% each[b] at 2 kg./a.u./yr.)	$ 1.73	
Supplemental rations[b] (cows and breeders only, at herd composition of 25%; at 5 kg./a.u./day for dry season of 180 days)	0.21	
Veterinary treatments[c] (symptomatic and specific vaccines, worming, labor, and non-recurrent treatment)	0.96	
Herd Maintenance Subtotal		$ 2.90
Weed control and maintenance of pasture composition (2 cuttings/yr. at 6 man-days/ha./cutting plus periodic burning and reseeding)[d]	15.00	
Fence maintenance (at 5 yr. replacement rate on 6 km. perimeter and 4 km. of divisions; 10 man-days per km.)[d]	0.20	
Cowboys (at 2 man-years/100 a.u. at one minimum wage each)[d]	0.40	
Temporary and Permanent Labor Subtotal		15.60
TOTAL ANNUAL LIVESTOCK MAINTENANCE COSTS		$ 18.50

[a] Prices are in March, 1984 dollars.

[b] Prices based on average per unit cost to farmers in Maranhão in 1983 (Fundação Getúlio Vargas, 1984).

[c] Estimate based on Kitamura et al. (1982).

[d] Estimate based on interviews with ranchers.

Table 6.3. Calculation of annual net revenue from livestock enterprise.

REVENUE FROM BEEF PRODUCTION

Dressed slaughter weight per animal[a]	146.70 kg.
Stocking rate (animals per ha.)[b]	0.75 head
Dressed slaughter weight per ha.	110.03 kg.
Value of beef at farmgate (per kg.)[c]	$ 0.929
Value of beef production (per ha.)[c]	**$ 102.21**

PER HA. CASH FLOWS

YEAR	REVENUE	MAINTENANCE[d]	NET CASH FLOW
1	0	(-) $ 18.50	(-) $18.50
2	0	(-) 18.50	(-) 18.50
2.8	$ 102.21	(-) 14.80	87.41

DISCOUNTED NET PRESENT VALUE (8% p.a.)	$ 37.44
CAPITAL RECOVERY FACTOR (2.8 yrs.)	0.4127
ANNUALIZED VALUE OF NET REVENUE	**$ 15.45**

[a] Based on data in CEPA-MA (1982).

[b] Based on agricultural census figures for 1980 (IBGE, 1984a).

[c] In May, 1984 prices in Pedreiras, Maranhão (CEPA-MA, 1984), converted to US dollars at the current official exchange rate.

[d] Calculated in Table 6.1.

adult beef cattle on a 200 ha. ranch. The total annual cost is estimated to be on the order of US$ 18.50 per ha.

The net cash flow generated by this system was determined on the basis of average reported data for the cocais and Pre-Amazonic zones of Maranhão (CEPA-MA, 1982). Dressed slaughter weight of cattle reared in this area was 146.7 kg., a weight achieved after an average of 2.8 years of grazing on improved pastures. Average stocking rates for animals in all size classes is approximately 0.75 head per ha (IBGE, 1984a). Using this stocking rate to determine per ha. dressed beef yields, I discounted the value of this beef yield to the present using May, 1984 regional prices net of annual maintenance costs (derived from Table 6.2) to the present.

The resulting net discounted cash flow was annualized, resulting in an estimated per ha. annual net cash flow from the enterprise of US$ 15.45, before consideration of capital investment amortization expenses (Table 6.3). This value represents the approximate annual per ha. return from the livestock enterprise, assuming a fully-formed herd under average maintenance conditions. At lower stocking rates, and taking into account the amortization of land, herd formation, and facilities investments, this value would be considerably lower.

Management of Babassu Stands

The palm forest, nurtured and spread as successional vegetation after shifting cultivation, is dominant in the cocais and costly to eradicate. As in the roça system, rather than clearcut the palms, most ranchers manage native babassu stands by removing senescent and unproductive palms, and suppressing the stemless juvenile palms by periodic cutting. The latter activity denotes the largest individual cost element in the livestock maintenance enterprise detailed in Table 6.2. A key economic concern is whether it makes sense to retain the productive palms over pasture and subject oneself to these high recurrent costs, or rather invest in palm eradication. To assess this decision, I will explore the benefits of native palm stand management and then compare the relative costs of management versus eradication.

Adult babassu palms[3] produce a single inflorescence with each new leaf. As leaf and hence flower production is high, averaging four per palm each year (Anderson, 1983), it has been thought that fruit productivity is far higher than is actually the case; estimates of per ha. fruit yields ranged as high as 15 tons (MIC/STI, 1977). In fact, an average of 56.7 percent of all adult palms in stands inventoried in four states (MIC/STI, 1982) rarely or never produce fruit. On average, a ratio of 5:1 of the inflorescences produced by palms in several study sites in Maranhão were male rather than potentially fruit-producing hermaphroditic flowers (Anderson, 1983), so that the average bunch production per tree is less

[3] Babassu palms require from 10 to 20 years to come to fruiting stage under optimal conditions, according to farmers interviewed. However, there are no controlled trials to confirm this.

than one each year. Actual stand productivity is estimated to range from less than one to a high of over six tons per ha. (MIC/STI, 1982).

There are many factors that influence stand productivity in babassu, among which are soil conditions (e.g., depth to plinthite layer, moisture retention capacity, and nutrient availability), site position (e.g., slope, proximity to streams, susceptibility to flooding), and annual climatic variation (SNLCS, 1984). Besides environmental conditions, stand management may have a significant effect on palm productivity.

Researchers and ranchers I interviewed suggest that the selective removal of unproductive palms and management of understory competition increase stand productivity by reducing overcrowding in roots and canopy. Ranchers report that they manage babassu palms at an average distance of 10 m. This would allow for a maximum density of about 115 palms per ha.[4] In fact, average stand density over pastures in the cocais is

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[4] In an arrangement aimed at optimizing stand density at a given distance between them, palms would be spaced so that each three palms form an equilateral triangle. The distance between rows of trees is calculated as the length of the perpendicular that bisects the equilateral triangle formed by each three trees. This length is found by multiplying the distance between trees by the constant: (sq. root 3)/2. The number of trees per unit land is then found by multiplying the number that will fit in one row at the given distance by the number of rows that will fit in the land unit. The latter is found by dividing the length of one side of the unit by the distance between rows. Therefore, in the case of a one ha. land unit, each row has 10 trees; the distance between rows is 8.66 m., and the number of rows is 100/8.66 = 11.5. The number of trees per ha. is thus 11.5 x 10 = 115. I am grateful to Luiz Fernando Martha for help in developing the general case for this calculation, and its inverse.

closer to 85 adult palms per ha. (MIC/STI, 1982:26), so that palms are actually managed at an average distance of 11.7 m. apart.[5] This density is significantly less than that found in unmanaged stands which may have as many as 200 palms of different age classes per ha. as well as numerous understory competitors.

The only experimental data available in the literature to support the contention of improved babassu productivity from stand thinning over any length of time are those reported by Valverde (1957), which show an increase in fruit production of between 80 and 100 percent three years after thinning from native stand densities to between 98 and 111 mature palms per ha. Yield increases were far less in stands left at their original densities observed as controls over the same period. However, it may be that the type and age of undergrowth vegetation are more influential than the density of palms in affecting stand yield.

In a survey by Mendes and Buna of 90 native stands in the cocais region (reported in Governo do Estado do Maranhão, 1978), fruit productivity of stands combined with pasture was nearly double of that of stands of equivalent density under secondary forests, demonstrating the yield-depressing effects of competition. Pasture stand productivity peaked at 3.2 tons with a density of 90 to 120 mature palms per ha., whereas even in young secondary forest growth the production level reached was only about 1.8 tons. As second growth increased in age,

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[5] Based on the inverse of the previous calculation.

competition increased, and yields were depressed even further. Similarly, data from 16 months of observation by Anderson (1983) of three nearby babassu stands in central Maranhão show a clear growth in yield as well as earlier fruiting among palms in a pasture stand as compared to those in a secondary and a primary forest (Figure 6.2).

Anderson (1983) and Mendes (in Mendes & Carioca, 1981) suggest that, although competition has a significant effect on yield, the palms' fruiting characteristics, rather than stand density alone, are determinative factors. Data from inventories conducted on a 50 ha. site near Lima Campos, Maranhão provide a basis for testing the relationship between stand density, fruiting characteristics, and yield.[6] The Lima Campos site has fairly uniform soil and associated vegetation conditions which provide some control against environmental effects on yields. The stand had developed as a uniformly aged succession over pasture, but was replete with understory competition since the pastures had been abandoned for some 10 years.

The data report estimated palm yield (using average regional bunch weight as a proxy to estimate actual harvestable fruit weight) and the number of palms per ha. Four

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[6] These data were obtained by researchers of the Agricultural Technology Division of the Instituto Estadual do Babaçu of Maranhão in 1983 during inventories undertaken to establish background conditions for analysis of agronomic factors influencing palm productivity. The site lies in the heart of the Cocais region, close to the municipio of Lima Campos, where household surveys were carried out for the current study. The palm productivity data are thus representative of conditions facing producers in this study.

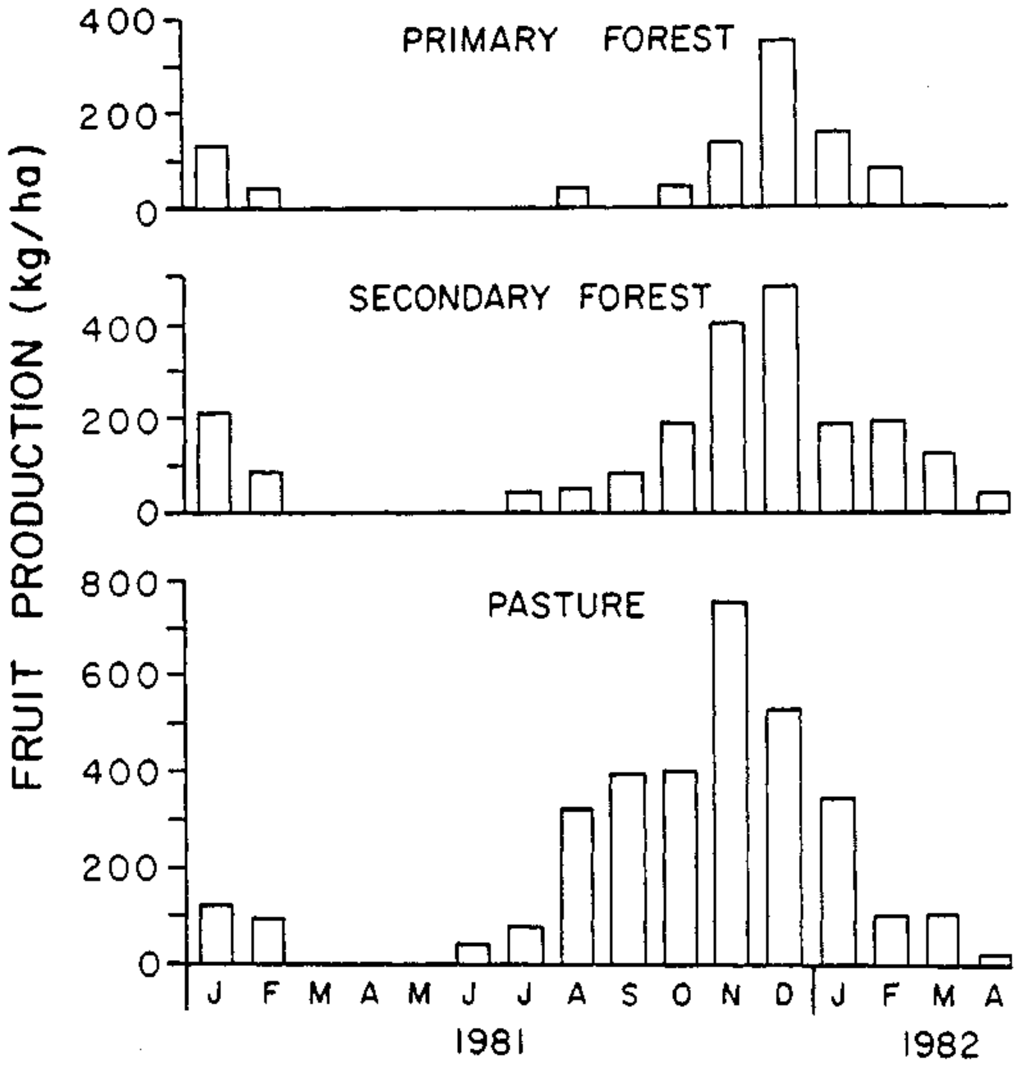

Figure 6.2. Monthly fruit production in babassu palm stands in Lago Verde, Maranhão (Anderson, 1983).

categories of palms were distinguished in the inventory: productive and unproductive mature palms, _capoteiros_ or young palms not yet producing inflorescences, and younger palms with emergent stems. _Pindovas_, or stemless juvenile palms were not counted, although they often represent the predominant understory vegetation in babassu stands.[7] Peak productivity in this stand was achieved at yields averaging 2.1 tons of fruit per ha. (the regional mean) at densities between 141 and 160 palms in all age categories for which data were collected. At this density level, an average of 60.1 percent of the total reported population consisted of mature, productive palms.

The relationship between total palm population and productivity was significantly positive, demonstrating steeply rising and then diminishing returns to increased density, typical of plant biological response curves (Figure 6.3). The data were fitted to a second-degree polynomial:

$$Y = a + b_1X + b_2X^2 \tag{1}$$

where Y = per ha. fruit yield, and X = number of palms in all reported growth stages per ha., to determine whether diminishing returns were statistically demonstrable. The coefficientfor the quadratic term was negative as was expected, but was insignificant due in part to the absence of a sufficient number of observations at the upper density range. Production

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[7] Pindovas may number as many as 6,000 per ha. (Anderson, 1983). Because the stand was fairly uniform in terms of understory growth, the counting of pindovas was unnecessary in gauging density conditions.

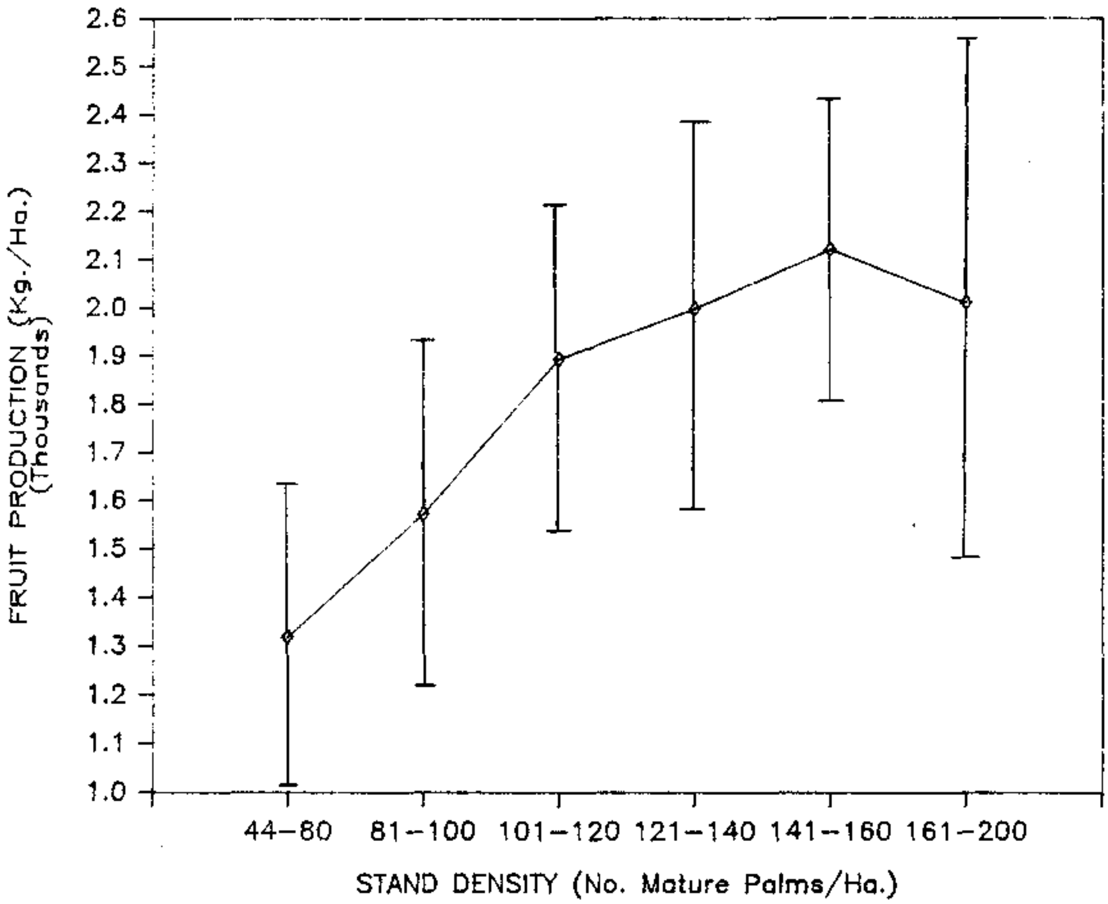

Figure 6.3. Response of stand productivity to density of mature palms: Lima Campos, Maranhão. Mean and 95% confidence intervals.

was maximized at 206 palms of all reported growth stages (obtained by differentiating the resulting equation with respect to density). However, this OLS linear estimation of density effects alone on yield explained only 15 percent of the variance in the data.

Consonant with previous studies (Anderson, 1983; Mendes & Carioca, 1981), the critical variable that affects stand productivity on the Lima Campos site is that of the sex ratio of inflorescences. Of mature palms, 73 percent were productive, with an overall average of 0.87 bunches per productive palm comprising the year's fruit output. The average ratio of unproductive to productive palms found in studies in four states (MIC/STI, 1982) was 2.3:1. An increase in either the proportion of palms producing hermaphroditic inflorescences, or in the number of bunches produced each year by each productive palm would greatly improve fruit productivity per unit land.

In a stepwise multiple regression on babassu fruit yields at the Lima Campos site, the addition of one variable: bunches of fruit produced per adult palm, increased r^2 from 0.110 for palm density alone to 0.800. Inclusion of both the variable for bunches per adult palm and that for the proportion of adult palms that are productive increased r^2 to 0.884. Further addition of a quadratic term for palm density (number of mature palms squared) at this stage did not add any explanatory power to the regression, and was omitted from the model. The resulting OLS equation was:

$$Y = -3359.9 + 14.9X_1 + 2585.1X_2 + 1794.8X_3 \quad (2)$$

"t" statistic: (-14.68) (17.62) (10.35) (24.16)

** ** ** **

where: Y = fruit production per ha.

X_1= total population of palms of all reported age classes

X_2= proportion of mature palms that are productive

X_3= bunches of fruit in current year's production per productive palm

** significant at the 99% level

Of these variables, only 11.2 percent of the variance explained by the regression was due to the contribution of density alone. Of the remaining 88.8 percent, the term for bunches per palm explained over half (56.6 percent) and that for the proportion of mature palms productive explained the additional 32.2 percent. There is some degree of correlation between these variables; i.e., density is negatively correlated with both the number of bunches produced per palm and the proportion of palms that are productive per unit land. However, neither positive nor negative autocorrelation was detected from the multiple regression results (Durbin-Watson D = 1.69, indeterminate at n = 100, k = 3); the depressing effect of density on both bunch production and palm productivity had low statistical significance. Palm density is clearly not the most important variable affecting babassu yields of the Lima Campos stand. Reducing the density of native stands is not, therefore, the only treatment which may enhance babassu fruit yields. Other management measures may have greater impact.

The commonly adopted practice of periodically cutting weed growth in pastures, as well as the consumption of herbage and subsequent nutrient returns to soil from livestock wastes, are widely regarded as beneficial to palm productivity. Such practices have evolved not only in management of pastures under native babassu stands, but also in management of coconut, African oil palm, and timber plantations elsewhere in the tropics (Ferdinandez, 1972; Nitis & Rika, 1978; Reynolds, 1980; 1981).

Cattle and other livestock grazing are often praised for reducing cover control expenses, important both to lessen competition with trees and maintain swards open to avoid that harvesters miss fallen fruit. Coconut output was reported to increase with higher stocking rates (up to 62 percent in one trial: Rika et al., 1981), and also as a result of underbrush thinning (Reynolds, 1980).

Research on pastures under coconut has been concerned primarily with identifying appropriate forages that will prosper under partial shade and cattle stocking rates that will not overwhelm grass regeneration or desirable species composition, while optimizing liveweight gains (Rika et al., 1981; Litscher & Whiteman, 1982; Plucknett, 1979). In establishing pastures within new tree plantations, the introduction of cattle without providing protection to seedlings results in damage due to browsing and trampling

(Lins, 1982; Hartley, 1977; Reynolds, 1980). On the other hand, some grasses grow too luxuriantly and may hamper development of young palms. Once they mature, however, these problems disappear as shade and grazing combine to impede rapid growth of the grasses.

A crucial dictum from research on pasture managed under trees is that "successful integration ... requires that both the main crop and the intercrop are considered as important components of the system" (Reynolds, 1980:41). In babassu, however, the "main crop" is not the palm, but the pasture. Babassu stands are not in general thinned and cleared of underbrush with the objective of improving their yield but, rather, to establish pasture or annual crop roças (Lopes & Moura Reis, 1979). The pasture and crop response then become primary rather than secondary or co-equal considerations.

The importance of babassu fallows to small farmers results in their maintaining productive trees in the roça, thinning and cutting back leaves to increase light penetration during the one or, at most, two-year crop cycle. The palm's ability to produce sufficient biomass to provide fuel and crop nutrients without necessitating removal of adult trees facilitates their retention, provided fallow cycles are sufficiently long to allow leaf regeneration in babassu.

In contrast, ranchers retain palms primarily to provide permanent shade for cattle. From the rancher's perspective, and a visual assessment, pastures also appear to perform better under palms than under open conditions. This may be due to the "nutrient pump" function generally attributed to woody perennials in agroforestry systems (Mongi and Huxley, 1979). Woody species derive mineral nutrients from subsoil horizons and return them to the topsoil through leaf and litterfall. Another hypothesis is that babassu and related palms leave nutrient-rich organic matter in their decayed stumps when they die; palm stands would thus gradually improve the soil profile (Furley, 1975). It is more likely that in these relatively young stands leaf and litterfall increase soil organic matter content and provide mulch for topsoils. Ranchers interviewed confirm that soils under palms appear to retain moisture and possess more organic material than similar soils under open conditions. Cattle also apparently prosper better under palm-shaded conditions than in open pastures.[8]

Economics of Babassu-Pasture Management

The retention of palms provides landowners with perceived benefits from the improved productivity of their herds and generates a small cash flow which assists in covering recurrent costs involved in managing herds and pastures. For the properties surveyed engaging in babassu resale, landowners

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[8] None of these hypotheses have yet been tested scientifically, although they are recognized as essential research issues (EMBRAPA, 1984). Although data suitable to test them are as yet unavailable, I have developed a conceptual model of babassu-pasture productivity as a contribution to future research in this area. The model and its assumptions are discussed in Appendix B.

reported an average annual production of about 50 kg. of kernels per ha. of land having some babassu coverage.[9] Since kernels constitute on average seven percent of fruit weight once extracted, this output represents a kernel extraction rate of only about one-third of the potential from average regional stands yielding 1.7 tons per ha. This average extraction rate is consistent with estimates of the proportion of total fruit output that is harvested in the babassu zone (Table 3.8).

During surveys carried out in 1983-84, landowners realized average margins of 25 percent on gross babassu kernel revenues having a value in May, 1984 equivalent to about US$ 18.40 per ha.[10] Kernel resale thus generated net cash revenues to landowners averaging US$ 4.60 per ha., before marketing expenses are deducted. While these revenues appear low, they must be compared with other sources of income to discern whether or not they represent adequate cause for stand eradication. When we take into account that cattle enterprises in this region generate net annual returns optimistically

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[9] Although land use was discriminated between babassu-pasture and babassu stands in combination with other vegetation, it was not possible for landowners to estimate whether the amount of kernels they resold was greater per unit land of babassu in pasture versus that from other stands. However, one agribusiness project developer noted a 50 percent increase in fruit production from babassu stands after thinning for pasture establishment.

[10] These values were estimated by weighting both monthly landowner margins and urban merchant purchase prices for kernels by each month's respective proportion of all kernel sales reported by peasant households interviewed during the 1983-84 survey period.

estimated at US$ 15.45 per ha. before capital and land amortization expenses are deducted (Table 6.3), the additional revenue from babassu represents nearly one-quarter of net per-ha. returns, even at a 40 percent extraction rate. Furthermore, anticipated revenue from babassu kernel sale is a recognized form of collateral for production credit, while the functionality of kernel sales and subsistence benefits to morador households makes babassu a useful means for securing a year-round laborforce. For this reason, most landowners prohibit cutting of productive palms by their tenants, as these provide a source of cash rents. Cutting of palms or selling palm products off the property are considered grounds for tenant expulsion in many areas in the babassu zone.

If so many positive reasons exist to retain them, why are many ranchers clearcutting babassu palms? One answer is that the costs of regular suppression of juvenile palms (pindovas) to reduce competition with pasture grasses leads ranchers to consider babassu a weed that should be eradicated. Pindovas persist in pastures, where open conditions permit their prompt regeneration after cutting. Babassu's cryptogeal germination protects its root system from repeated cutting and burning. Pindovas regenerate vigorously unless the soil is graded and dormant seeds buried, systemic herbicides are applied (Maciel, n.d.), or yet, the growing point of every seedling killed by either pulling them up by the roots or driving a stake into their hearts (Anderson & Anderson, 1985).

Ranchers report from one to three annual cuttings of pindova leaves and other invasive species in pastures. When the weed problem becomes especially troublesome, the leaves are set afire after cutting. Annual labor costs for weed control averaged the equivalent of US$ 15 per ha. for the 10 man-days of labor required to accomplish the task among survey farmers (Table 6.2). This cost exceeds the potential net revenues from resale of kernels produced from average regional stands at current prices, even if all fruit were to be extracted. Nevertheless, the expense to surmount the pindova problem by clearcutting palms and soil grading is prohibitive to the majority of ranch operators. The costs of mechanized land clearing and grading are reported to range from US$ 270 (CIMEC, 1983) to a cost ceiling of US$ 300 per ha. in federal-ly- subsidized livestock development projects (SUDENE, 1984b). Even if this initial cost resulted in a total elimination of annual pasture maintenance expenses, it would require from 18 to 20 years at zero interest before this cost saving would justify the initial expense, not counting the cash income derived from kernel sales.

In contrast, the combination of manual underbrush clear-ing and thinning of overly dense stands in the cocais for pasture establishment under babassu palms has costs estimated at a maximum of US$ 60 per ha. (Lopes & Moura Reis, 1979). In most cases of pasture establishment and expansion without federal subsidies or credit, landowners contract small farmers to thin unproductive and senescent palms in preparation for annual crop roças, on the condition that, rather than pay rent, they plant pasture grass into the crop field after the harvest. Thus there are few if any pasture establishment or palm thinning costs on the landowner's part. This mutual accommodation also extends to the maintenance of pastures and palms. Landowners reported that, instead of paying wages, they are increasingly contracting with babassu gatherers to carry out pindova cutting in return for exclusive rights to the palm fruit in the weeded area.

For the landowner, then, the retention of babassu palms in pastures is a costless outcome of the transition in land use from peasant agriculture to cattle ranching. The system is maintained by peasant households whose need for off-farm income has increased as a result of the restriction in land for shifting cultivation. Babassu gathered from pasture stands has thus become more important as a source of peasant income.

Explanations for Babassu Eradication

If the babassu-pasture system is profitable for the landowner, the question remains: why are palms being cleared? Besides the pindova problem, one answer is that the capital invested in improved cattle ranching is purely speculative, as suggested by research on the political-economic rationale for pasture expansion in the Amazon (Hecht, 1985). In this view, the economic rationale for land use decisions is unrelated to the sustainable returns from the enterprise itself. Instead, access to subsidized investment financing is the prime motivation for agro-pastoral development. The opportunity to siphon-off resources from these investments to apply elsewhere, and the anticipated capital gains from speculative investment are the driving forces behind the rapid transition in enterprise organization. Since the investment in land clearing and pasture establishment is made at government expense, ranchers have an incentive to clearcut palms.

Pasture Expansion Projects in the Eastern Amazon

The specific incentives that contributed to livestock expansion in eastern Amazonia (a region that includes a substantial portion of the babassu zone of Maranhão[11]) during the 1960s and 1970s included: (1) allowance for reinvestment of corporate taxes due in frontier agro-industrial projects;[12] (2) a tax holiday of from 50 to 100 percent for 12 years on the livestock enterprises themselves;[13] (3) duty-free import and export allowances; and (4) regional government credit and land concessions. These subsidies amounted to as much as 85 percent of the total costs of project investment. The remaining resources were typically

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[11] Parts of the state of Maranhão west of 44° W. are included in the Amazon legal territory.

[12] Law 5.1744 (October 1966) allowed that 50 percent of a corporation's tax liability could be invested in Amazon development projects.

[13] Up to 50 percent of taxes on projects established by 1966, and 100 percent for those established up to 1972, were exempt.

contributed by the investor in the form of land in lieu of capital; since land was often obtained at concessionary terms, Amazonian projects demanded little real capital outlay by investors.

To obtain significant capital gains from the investment, ranchers applied the publicly subsidized funds at the outset in land improvements and purebred cattle. By two years after beginning forest clearing and planting seed, pastures were typically being grazed at high stocking rates. Ranchers began to sell-off the herd when pasture degradation commenced shortly thereafter.[14] Once all pastureland had been depleted, usually after fewer than eight years, the remaining herd was liquidated or sold with the land to the next investor. To achieve a high rate of return, investors benefited from rapid appreciation of land values (Norgaard et al., 1985). While the degraded pasture may have been worth little in productive terms, its exchange value was substantial, due to the subsi-

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[14] Data from Hecht (1982) show typical pasture management to increase stocking rates quickly to 4.0 animal units (a.u.) per ha. At these stocking rates, forage quality is rapidly degraded, so that in only a few years, the average stocking rate declines to below 0.5 a.u. per ha. However, the large ranch area permits total herd size to remain high until all pastures are established. Following this point, the herd is typically liquidated, and the property transferred. Use of purebred cattle enables ranchers to profit more from liquidation than from continued management of pastures at sustainable stocking levels. This stock finds a ready market for breeding on properties where similar practices are being followed. It is not readily apparent that ranchers realize when they begin an enterprise of this type that pasture degradation will occur as quickly as it does. However, the fact that they overstock when the new pasture is formed and at its peak quality indicates that they are far more concerned with reaping the greatest possible immediate returns from the enterprise, without regard for its long-term sustainability.

dies still available for making improvements in the property (Hecht, 1985). Real land values in Amazonia increased dramatically even in areas where pasture degradation had made soils worthless for agriculture.

But why invest in cattle ranching rather than cash crop production, for example, if the investments were essentially made at public expense? Hecht (1985) argues persuasively that a combination of Brazilian political-economic conditions and global influences shaped policy in support of pasture expansion in the Amazon rather than more labor-intensive or land conserving alternatives.

The ideal of national geopolitical integration was wedded to the objectives of the multilateral aid and finance community seeking to enhance trade in low-cost beef from range-fed cattle.[15] Pastures could be planted over large expanses of land that could be rapidly cleared of tropical forest vegetation using mechanical equipment. Herding is essentially undemanding of labor, which fit well with the Amazon's low population density, and somewhat higher rural wage rates. Cattle ranching has long been the Latin American latifundia land use of preference. This preference persists in the mind-set of potential agribusiness investors who were stimulated by the attractive government subsidies to buy into frontier livestock enterprises. The long-term negative

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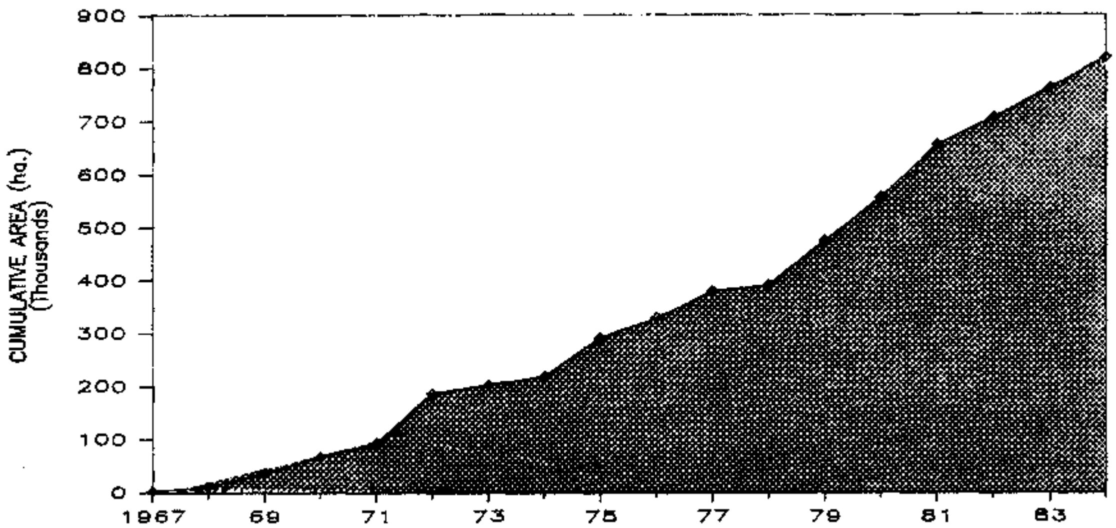
[15] Ironically, cattle ranches in the Amazon have generated negligible foreign exchange revenues for Brazil. In fact, the state of Pará, where many ranches were established, remains a net importer of beef (Hecht, 1985).

interest rate subsidies provided for initial land improvement and herd formation made livestock enterprises far more attractive than agriculture, whose input costs would have to be met with short-term credit at higher interest rates (Tendler, 1980). Lack of knowledge of appropriate perennial crops that could be established at minimum risk under humid tropical conditions militated against any serious efforts in this regard. This combination of factors ensured that cattle ranches would be encouraged as the principal enterprise at the Amazon frontier from the 1960s to the present.

During the period 1967-1982, cattle ranching projects covering a total area of 7.8 million ha. throughout the Amazon basin were approved by SUDAM[16] (Norgaard et al., 1985). In Maranhão, the growth in pasture land use in absolute and relative terms in the cocais has been described earlier in this chapter. Figure 6.4 shows the number of livestock ranching projects and their cumulative area financed by SUDENE and SUDAM in Maranhão from 1967 to 1984. A total of approximately 96 projects covering a cumulative total of nearly 820,000 ha. were approved and funded during this period in Maranhao by the Federal Government. An additional 19 projects covering 510,000 ha. were undertaken with land concessions and financing arranged by the state colonization corporation,

[16] SUDAM is the Superintendência para o Desenvolvimento da Amazônia, the regional development planning agency.



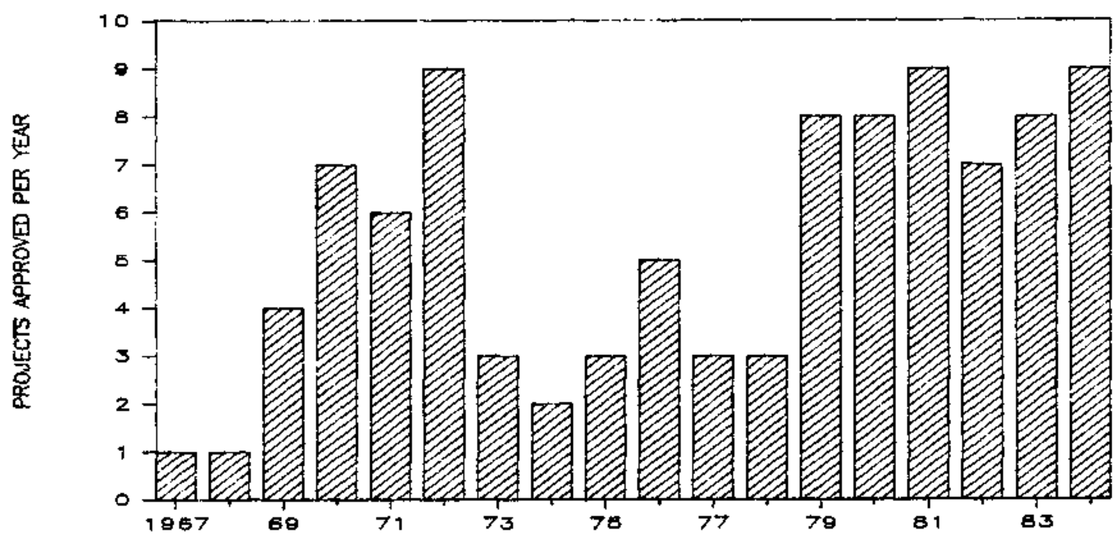


Figure 6.4. Annual number and cumulative area of SUDENE and SUDAM-financed livestock development projects in Maranhão: 1967 - 1984 (FINOR office, Maranhão; unpublished data; Amaral Filho, 1983).

COMARCO.[17] Average ranch size for all 115 projects is 11,536 ha. The size of livestock projects assisted expresses a wide range, however (s.d. = 9,956.5 ha.), with the largest projects in the COMARCO area being over 50,000 ha. in size. To give some idea of magnitude, the size of each of the latter farms was somewhat greater than that of all land in farms, primarily dairy cattle operations, in Tompkins County, New York in 1982, where farm size averaged 87 ha. (US Dept. of Commerce, 1984).

Brazilian federal law establishes guidelines for the proportion of total project area that may be deforested.[18] In the Amazon region, where most projects were established,[19] at least 50 percent of project area must remain as forest reserve or be replaced by plantings of homogeneous tree species. Indeed, not all of the area in projects was deforested for pasture establishment.[20] While data on deforestation for

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[17] The specific timing of approval of the COMARCO projects was not available, hence they are not included in Figure 6.5. However, Wagner (1981a) provides data showing that most of these projects were established after a state law (no. 3230) in 1971 established COMARCO, and a federal senatorial resolution in 1973 allowed the state to cede lands for "colonization" along the Amazon frontier of Maranhão. According to Wagner (1981a), this act, while nominally aimed to provide lands for farmers, has in fact turned "the breadbasket of the Northeast" into "one vast pasture."

[18] Codigo Florestal, Executive Law No. 4771, of September 15, 1965.

[19] Of the projects approved prior to September, 1981, 58 percent of the SUDENE project land area, and 96 percent of the SUDAM-assisted project area are located in Amazonian microregions (Amaral, 1983). All the COMARCO area lies in the Amazon legal territory.

[20] Data on projects assisted by the Northeast tax reinvestment fund FINOR shows that most projects rarely reach their programmed objectives for pasture establishment or herd

individual project sites is unavailable, researchers on Amazonia have found that the rate of deforestation in Maranhão increased exponentially during the 1970s (Fearnside, 1984). The areas that were deforested were not all covered with babassu stands. Nevertheless, given the palm's predilection for lowland sites having better overall soil conditions for pasture establishment it is likely that much of the project area located in the babassu zone has been cleared of the native palm stands.

Further, the area involved in federally subsidized project development understates the total area converted to pasture. Estimates by Tardin (1982) based on analysis of satellite imagery suggest that as much as three times the area included in development projects in Amazonia has been deforested in areas experiencing particular livestock expansion pressure. The babassu zone of Maranhão is definitely one such area.[21] It may be conservatively estimated based on the preceding discussion that at least 2.5 million hectares or one-sixth of all agricultural land lie within modern cattle ranches in Maranhão. Of this area, at least 1.25 million

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formation (Gasques, 1983), a fact which supports the earlier characterization of such investments as speculative rather than productive.

[21] In Maranhão, between the 1975 and 1980 census alone, the number of cattle increased over 57 percent, or 9.5 percent per year. The per-cow calving rate in the Mearim micro-region averaged a respectable 60 percent. Herds were also incremented by purchase at a rate of 7.1 percent annually. These growth rates allowed ranchers to sell or slaughter 14.1 percent of their herds each year while sustaining a 2.3 percent mortality due to disease or natural causes (IBGE, 1979 and 1984a).

Figure 6.5. Mechanized clearcutting of babassu palms for a livestock project in Maranhão (photo J. Alves).

ha. have been deforested for pasture. At babassu coverage rates averaging 50.9 percent in the regions where much of the clearing for cattle ranching is located,[22] this would account for nearly 650,000 ha. of babassu stands, or roughly 14 percent of the state's stands inventoried from 1977 satellite imagery (MIC/STI, 1982).

Babassu stands in livestock development projects are given no greater protection than any other forest species under federal law. The 50 percent forest reserve required under the Forest Code in Amazonia could thus consist of nonbabassu forest, and all areas actually cleared for pasture could have babassu coverage. The palms' association with the better soils would tend to result in their being cleared for pasture establishment. Since federal funding is available for the initial clearcutting of forest cover up to US$ 300 per ha. (SUDENE, 1984b), mechanized removal of palms and grading to reduce later pindova regrowth are standard practices on these projects (Figure 6.5).

Legislation Protecting Babassu from Deforestation

In May, 1979 the state legislative assembly of Maranhão approved law number 81 which prohibited the cutting of babassu palms in the entire state. This law was superseded by a 1980

[22] This figure is the average effective coverage rate for babassu stands in the Cocais, Baixada, Imperatriz and Pre-Amazonic ecological zones of babassu occurrence in Maranhão (MIC/STI, 1982).

act of the state's governor[23] which, among other things, prohibits cutting or harming babassu palms except: (a) when thinning palms to augment productivity, (b) in areas destined for public works, or (c) in agricultural development projects, as long as: (i) palms are left standing at no more than 10 meters distance; (ii) palmito is not extracted except when thinning; and (iii) herbicides not be applied to clear palms. The law metes out heavy penalties against infractors, and denominates members of rural workers unions as legitimate parties to notify the pertinent state agency of infractions.

Despite the above mentioned state law, babassu eradication continues. Neither the federal agency responsible for regulating forest reserves,[24] nor the state agency denominated to punish infractions of the babassu protection law[25] possess adequate personnel to police or bring suit against infractors. No case has actually been adjudicated. In fact, the only cases in which forest protection statutes were applied in Maranhao were in executive acts exempting several major land development corporations from their requirements.[26]

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[23] Executive Law Number 4154, January 11, 1980, signed by Governor João Castelo.

[24] Instituto Brasileiro de Desenvolvimento Florestal - IBDF.

[25] Secretaria Estadual de Recursos Naturais - SERNAT.

[26] Decrees Nos. 5549 and 5550 of March, 1975 permitted the firms involved in establishing cellulose and cane operations in the area of Caxias, Maranhão to deforest a total of 65,000 ha. of palm stands.

The state law's explicit naming of peasants as the complainants in potential suits, while legitimizing grievances by those most vulnerable to babassu eradication, indirectly legitimized the peasantry's property rights to the palms. Yet, the damaged parties were powerless to defend their rights even when explicitly established by law. Here we find a clear instance of the tragedy of the non-commons, since even the placement of liability on the perpetrator of external economic costs did not effect a market solution, being thus insufficient to achieve a Pareto-optimal solution.

Representatives of SUDENE responsible for overseeing agricultural project compliance with technical norms and legal constraints could not explain why most ranchers persisted in eradicating palms. There are no strictures in the technical criteria for project approval which explicitly require ranchers to clearcut trees where pastures are to be planted. In practice, however, the inclusion of mechanical clearing and grading as allowable costs (SUDENE, 1984b) acts as an incentive to eradicate palms. In one case, that of a SUDENE livestock project beneficiary who is also a babassu oil manufacturer, agronomists assigned to the project were said to have insisted that all palms be removed. At the landowner's counter- insistence, babassu stands were instead thinned and pastures planted under them, reportedly resulting in a significant increase in palm productivity and no harm to the pastures.

It is the contention of members of the state industrial association, chiefly made up of babassu oil producers, that the principal reason that landowners are eradicating babassu is that they lack technical information on the palm and its value. In the view of local industrialists, these modern ranchers, many of whom hail from other parts of Brazil and as far away as Japan, are cutting the palms because they simply aren't accustomed to their rational exploitation. The case cited above suggests that they are being provided with faulty technical assistance from the federal agronomists assigned to their projects as well. With the help of an educational campaign, owners of babassu stands would learn how to organize rational systems of palm management and fruit gathering so as to turn a profit for themselves and ensure the continuing availability of babassu kernels for the industry.[27]

The industrialists had failed to realize that the decisions of these landowners were not made on faulty technical grounds alone, but rather depended on a distinct economic rationale to that of the traditional latifundia.[28] The discussion in Chapter III of change in land use and labor relations in the case of sugarcane and cellulose manufacture

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[27] The industrialists' viewpoint on the problem and its means of resolution was expressed in these terms at a meeting of the Industrial Federation of Maranhão devoted to the babassu deforestation issue, which I attended.

[28] The emergence of agro-industrial capital, stimulated by the state to transform rural production decisions with respect to technology and resource use in Brazil, has been treated extensively in the literature (see Goodman, 1984 for a review).

in Caxias illustrates the point. Latifundia of Caxias, whether or not they are under new ownership, are being gradually subordinated to the needs of the agro-industrial projects whose labor and raw material markets are now the pace-setters of the regional economy. Similarly, the pace-setters in the cocais and Amazon frontier areas in Maranhão are the large cattle ranching operations, and more recently, land speculation around the Carajás export corridor. Their low labor demands and predatory requirements for extensive land areas are placing progressively greater pressure on the remaining small farming operations.

Legal protection or technical information as mechanisms to ensure retention of babassu palms were insufficient to guard peasants from the effects of agro-pastoral development. The specific repercussions of these changes on the peasantry are illustrated with reference to change in property rights to land and palms in the concluding section of this chapter.

Changes in Property Rights over Land and Palms

Ranchers' objectives are seldom congenial with peasant access to babassu stands on their properties. They frequently complain that gatherers cut fences, set wildfires either purposefully or due to neglect of charcoal kilns, leave holes in the ground after making charcoal, or leave broken husks on the ground. Cattle then were lost or hurt by straying through the fences, falling into the holes, or cutting their hooves on the broken shells. Unmanaged fires harm pasture growth and endanger buildings and livestock.

The end result of these conflicts has been a general tendency by ranchers to restrict peasant access to babassu fruit collection in pasture stands. Several degrees of prohibition against collection exist, as documented by Anderson and Anderson (1983) in the municipio of Bacabal. While some ranchers allow fruit to be gathered, for example, it is generally required that fruits be carried off the ranch or at least off the pasture before breaking them; charcoal may not be produced in pastures. Instead of involving themselves in relations with the host of peasants clamoring for access, ranchers are now more likely to rent lots in babassu stands to individuals who can mobilize gatherers and animals to get the job done quickly and with minimal damage. When these restrictions are added to the growing tendency toward palm eradication on the better capitalized estates, there is a real reduction in peasant welfare.

The upshot of these alterations is that household labor allocation must be altered, and the overall earnings from babassu for a given expenditure of effort are reduced. Contracting with a stand renter rather than dealing directly with a landowner tends to reduce earnings; women I interviewed who had been assembled to collect and break fruit by stand renters only were entitled to half of the kernels they extracted, and were required to produce charcoal for the renter as part of the bargain. As properties where collection is allowed grow farther removed from peasant residences, the gathering activity demands more time. Carrying bulky and heavy fruits from the pasture to the home or breaking post is difficult for those who own no beasts of burden. Men will be needed more frequently to assist women and children in gathering, thus reducing the time they have available for food production or wage labor. As the ease of gathering declines, it might then be thought that peasant households would devote less of their labor resources to this pursuit. However, the conditions which effect reduced access to babassu groves are the same ones threatening the internal resilience and continuity of the roça and agricultural employment opportunities.

As the land available for annual crop rogas is reduced and their productivity decreases due to shorter fallows, peasant agriculture is seriously jeopardized. If, in addition, access to babassu groves as well as off-farm employment opportunities are restricted by changes in land use and technology, peasants have little recourse but to emigrate. The regional economy is unable to absorb the expelled laborforce in cities, already teeming with unemployed people. Migrants are increasingly departing the babassu zone for unclaimed lands in the Amazon.

Conclusions

The first part of this study has focused upon the nature of agricultural enterprises, their structure, interactions and the processes through which they are being transformed.

Babassu's importance to the majority of the rural population has been identified as a source of cash and subsistence income crucial to their overall income formation and capability to sustain themselves in regional agriculture. To the rancher, the palm stands provide tangible benefits that make their increasing eradication difficult to explain except as a response to financial incentives provided for large-scale livestock development at the Amazon frontier.

Agrarian change in the babassu zone is in progress from two directions simultaneously. First, the most productive lands in older areas of settlement in the cerrado are being converted from extensive grazing and crop production under babassu palms to mechanized cane, pulpmill feedstocks, and some planted pastures, as described in Chapter IV. Second, as described in this chapter, the cocais and Amazon frontier, formerly areas where small farmers could settle with relative ease on unclaimed land, have been converted to large-scale livestock ranches. In the cerrado, the resident laborforce on former latifundia are being transformed into seasonal laborers at piece rate for planting and harvesting cane. On the western frontier, squatters on untitled lands are convinced by speculators to give up their nominal rights to title; they are then permitted to remain on the property if after each crop harvest they sow the land to pasture grass. Eventually, they must move on, whether further into the advancing frontier as a footloose rural laborforce or, as migrants to cities, swelling the ranks of Brazil's vast urban underemployed.

From what is happening in the babassu zone, we can begin to see some common threads to the process, and how they effect alterations in the rights of property in land and palms. The main thrust common to most of the changes that have been perceived is that of resource privatization. As capital is invested in new agricultural ventures, the landless people who previously had been able to secure a piece of land for a roça or some babassu fruit to break (whether within a latifundium or on an unclaimed tract) now find this more difficult.

Peasants now have to travel further from wherever they are able to build a home (often now on the side of a state right- of-way rather than within an estate or untitled area) in order to tend their crops and collect babassu fruit. Contract relations providing access to land for shifting cultivation are undergoing revisions: rents increased or changed in form and peasants are now disallowed from planting longer-cycle crops that slow the pace of pasture expansion.

In addition, ranchers and mechanized crop growers were cutting down palms at a visibly increasing rate, to which both the babassu oil processors and the peasants responded with anxiety. On two occasions in 1982 and 1983, rural workers union representatives held interstate conferences to discuss problems associated with access to babassu stands and marketing of products by the peasantry. Lines of action suggested at the first conference by union leaders were not widely followed. At the second conference, it became clear that efforts by babassu producers to express their legal rights under the national land and labor statutes to free marketing of shares, minimum wages, or squatters rights to palms had resulted in

> pressures, threats and imprisonment practiced by landowners, guards, henchmen and the police . . . Abundant labor in the area facilitates the proprietor's imposing work conditions and makes organized workers union activity difficult. . . In the case of cutting of palms there is only punishment when workers are involved. Large landowners are not punished.
>
> (CONTAG, 1982 and 1983)

As suggested in this chapter, even where legal liability for actions harmful to the peasantry has been established, and property rights recognized yet not legitimized — such as in the prohibition against babassu cutting — those bearing the brunt of the external costs are unable to exact compensation.

Change in rural enterprises and associated collection rights, combined with eradication of palm stands in areas most accessible for extraction are undoubtedly bringing a decline in real income among peasant households. These changes, when combined with limitations upon land available for shifting cultivation, and reduced employment on enterprises now oriented only toward beef production are reasonable explanations for the babassu zone's becoming one of net outmigration during the 1970s. These outcomes, described in Part I of this study, represent one facet of the tragedy of the non-commons in the babassu case. The repercussions of these changes on the dynamic and organization of the babassu oil industry, and the implications for peasant welfare of industrial innovation in babassu fruit processing, are the subjects of Part II.

CHAPTER VII.

THE RISE AND DECLINE OP THE BABASSU OIL INDUSTRY

Industrialists in the business of crushing babassu kernels to make vegetable oil for edible and industrial purposes see their stability and future growth as closely linked with that of their raw material supply, and with market conditions. Oilseed cost represents the largest component of costs of vegetable oil production in the babassu industry. Yet there has historically been little vertical integration of babassu production with kernel crushing. Babassu kernel has remained an extractive product obtained from diffuse sources through complex intermediary chains.

Instead of improving raw material supply security, industrialists have focused on process technology improvements and scale expansion. These strategies have enabled them to minimize the per-unit costs of converting the raw material to marketable products and to ensure that peak seasonal raw material flows can be quickly processed. This is important in a volatile market where considerable profits may be made when international markets open, but where oil may be sold near kernel cost when demand declines. The low cost of industrial capital available to investors in Northeast Brazil since the 1960s has enabled such changes in process technology with minimal impact on the firms' financial condition. However, the national economic crisis in the early 1980s severely rationed working capital and compressed final demand for industrial oil products, penalizing all but the most efficient operations. This chapter assesses the contribution of raw material supply, technology, and financial and market conditions to the overall health of the babassu industry, as well as the impact of actions by landowners to eradicate or restrict access to babassu stands on the industry's future viability.

History and Organization

The babassu oil extraction industry is currently composed of perhaps 50 operational firms located in four states in Brazil: Maranhão, Piaui, Ceará and Goiás. The vast majority of these firms are based in Maranhão.[1] The number of firms operating in any given year and the length of the crushing season vary considerably, according to a range of economic and physical factors to be described in this chapter.

The number of firms in existence, whether operational or not, has increased significantly over the past decades, demonstrating few barriers to entry in the industry as a whole. In 1951, there were reportedly 21 firms using babassu kernels as raw material in Maranhão and Piaui; by 1961, this number had increased to 32 (Markley, 1963), and by 1967 to 56 (Leal et al., 1972). During 1981, there were 34 firms operating in Maranhão alone (Amaral, 1983). The latter factories

[1] It is not known with certainty how many vegetable oil extraction firms in Brazil currently use babassu kernel as a raw material, since the national statistical bureau ceased to record industrial utilization of specific oilseeds in the 1970s.

had combined annual crushing capacity of over 500,000 tons of kernel. While these enterprises are adaptable to using other oilseeds, they have developed in the region because of the existence of a local raw material source.

The industry stimulated kernel supplies to grow considerably, causing babassu kernel to replace cotton as the region's principal industrial raw material by value during the 1960s. In central Maranhão, babassu kernel now constitutes up to one-third of all primary sector output (IBGE, 1984a). The babassu industry accounts for a considerable share of the state's gross internal product, having contributed the majority of Maranhão's revenues from value-added taxation on marketed goods from 1974 to 1977 (Table 3.3). In 1981, babassu kernels in Maranhão generated nearly US$ 54 million in revenues to kernel producers, landowners, and middlemen. Babassu kernel oil and by-products continue to provide the state's major export products by value, representing 62 percent of all exports between 1979 and 1983 (CACEX, unpublished data).[2] In Brazil, babassu kernel constitutes 88 percent of all nondomesticated vegetable oilseeds by volume (IBGE, 1984b) and is the nation's principal source of lauric-type industrial oil used in soaps and cosmetics industries.[3]

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[2] Recent kernel, oil, and by-product prices, and export data were obtained from the Bank of Brazil Export Commission (CACEX) in São Luís, Maranhão.

[3] Lauric oils are those which have, among their free fatty acids (FFA), lauric acid as a principal constituent; other oils of this type include both coconut and African palm kernel oil. Besides lauric acid (averaging 46 percent of all FFA), the other principal fatty acids present in babassu oil

Although there is considerable production of coconut, the most obvious substitute for babassu produced in Brazil, the vast majority of coconuts are destined for direct consumption or the baking and confectionary industry rather than for copra. Only spoiled coconuts are used to some extent in soap manufacture. To protect domestic vegetable oil industries as well as conserve scarce foreign exchange, import tariffs and restrictions have limited the entry of foreign oilseeds or processed oil and products into Brazil.

Prior to 1960, a larger share of kernel oil was extracted outside the babassu zone than within. From the early 1920s, when babassu kernel first appeared in trade statistics, until the onset of the Second World War, most kernels were exported to other nations.[4] The threat of war boosted demand for lauric oils in Europe and the U.S., stimulating the babassu

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are the oleic (16 percent), miristic (15 percent), and palmitic (10 percent). Oils having high lauric acid content are generally important for soap manufacture, because their high melting point ensures their stability in solid form even at fairly high temperatures. Saponification, carried out by addition of caustic soda, consists in neutralizing the FFA, leading to formation of soap and glicerol as a by-product. Besides bar soap, lauric acid oils are used in the manufacture of margarines, shampoos, moisturizing and cleansing lotions, toothpaste, detergents, and industrial emulsifiers (FTI, 1982).

[4] In 1935, the United States and Brazil signed a Trade Agreement, exempting babassu kernels from the three percent trade duties imposed on similar goods. This set a fixed price for babassu kernel entering U.S. markets. In 1942, after the Pacific War cut-off Philippine copra supplies, the "Overall Babassu Agreement" was signed between the U.S. and Brazil. This provided a guaranteed market at preset prices for Brazilian babassu kernel, on the condition that 70 and, later, 50 percent of all babassu production be shipped to the copra-starved oil mills of the U.S. This agreement was disappointing to both parties, and was allowed to lapse in 1947 (Markley, 1963).

kernel export business, which peaked in 1939 at nearly 50,000 tons, nearly all of which went to the United States. Import substitution during the 1930s and 1940s led to growth in wage goods industries in southern Brazil, which consumed the majority of babassu kernels for edible oils and soaps. Under pressure from domestic industrialists, babassu kernel exports have been limited since 1951 (Figure 7.1).

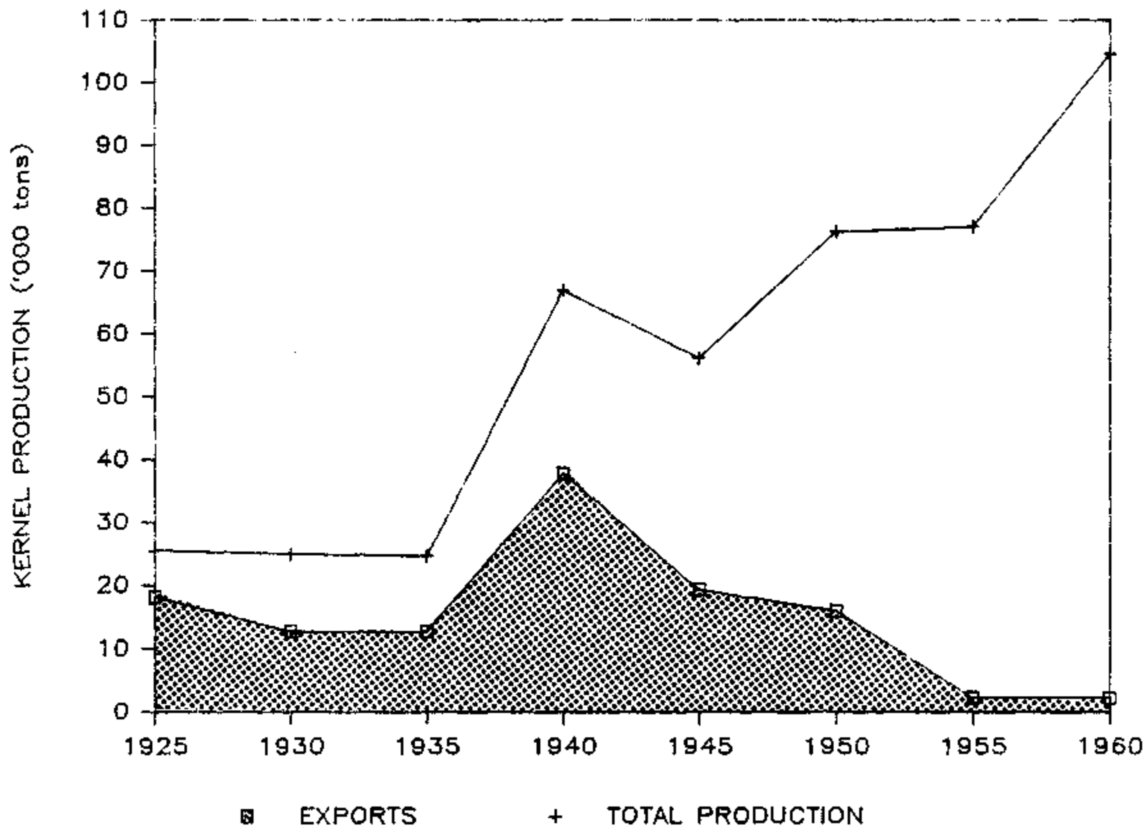

Figure 7.1. Annual production and exports of babassu kernels in Brazil: 1925 - 1960. Annual data are 5-year moving averages (Markley, 1963: 82-83; Banco do Nordeste, 1977: 180).

In the early 1960s, several factors gave impetus to the development of an oil extraction industry based within the babassu zone itself. Among these were prohibitive shipping costs and quality degradation of kernel transported to the south, the potential for investors to export press cake at higher-than-internal market prices, and investment capital freed up from the region's deterioriating cotton textile industry (Amaral, 1983). Firms in other parts of the country that formerly extracted oil from kernels transported from the babassu zone began to purchase industrial babassu oil for refining or soap manufacture. Figure 7.2 shows this change in the spatial structure of the babassu industry, as the proportion of Maranhão's exports to other states due to babassu kernel shipments dropped precipitously, and the local industry grew rapidly, settling by 1970 at a level of nearly 60 percent of all Brazilian babassu oil production. Paralleling the drop in kernel shipments was a rapid rise in shipments of babassu oil from Maranhão.

The infrastructure to bring about this shift was created in large measure by the firm Oleaginosas Maranhense, S.A. (OLEAMA), which converted a number of tankers to carry babassu oil from São Luis to its parent firm, União Fabril Exportadora, in Rio de Janeiro. Other firms were encouraged to ship oil on these tankers also, enabling OLEAMA to cover shipping costs and making oil extraction an attractive investment.[5]

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[5] This section draws from Amaral (1983), as well as my own interviews with industrialists and reading of the historical literature on the babassu industry.

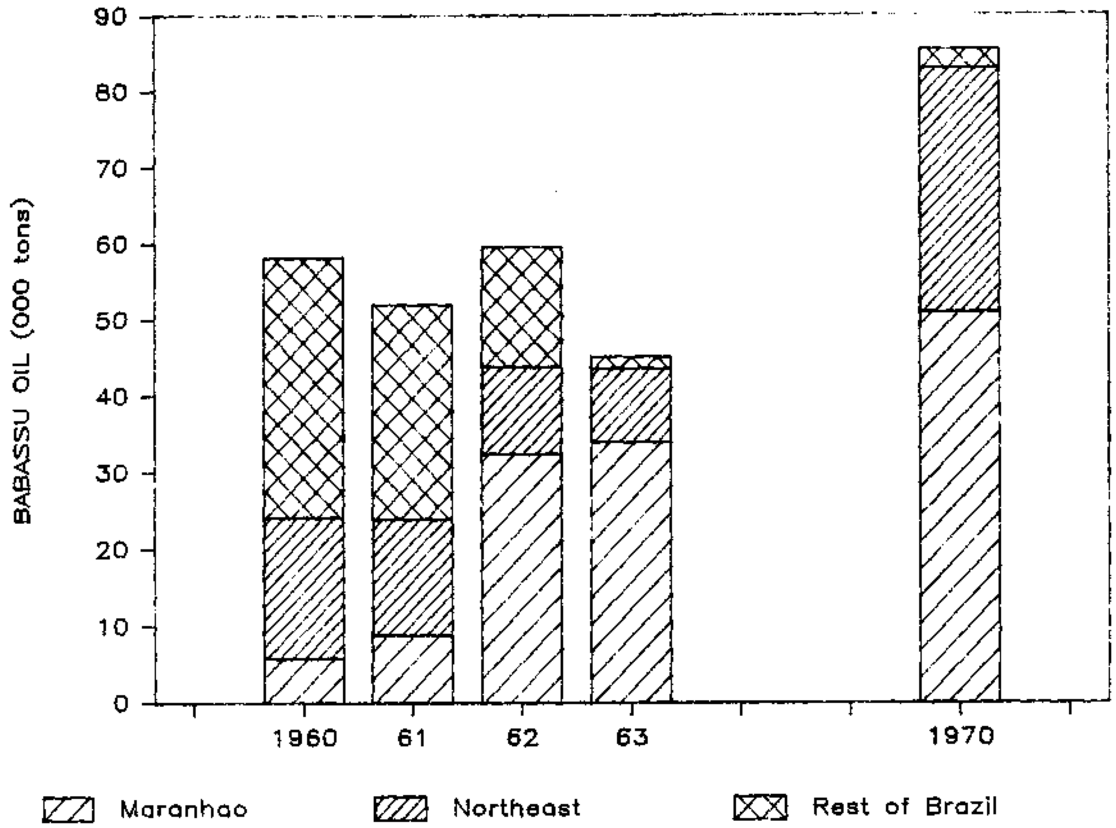

Figure 7.2. Spatial distribution of babassu oil production: 1960/63 and 1970 (FTI, 1982: 4-23).

Most of the oil extraction firms were established with local capital by merchants and large landowners formerly involved in export of kernels or textile manufacture. They are overwhelmingly natives of Northeast Brazil. The vegetable oil industry controls the state industrial association in Maranhão, whose lobbying was instrumental in securing raw material quality control, pricing, and extant resource protective legislation regarding babassu (see Chapter VI). This organization is a small, but vocal interest group which has also been able to restrict imports of foreign substitutes, while keeping the door open to babassu oil exports when foreign markets are propitious.[6]

The largest firms and the most concentrated number of factories are found in the major urban centers of the babassu zone, principally São Luis, Bacabal and Caxias in Maranhão, and the Teresina/Timon urban area on the Parnaiba River between Maranhão and Piaui (Figure 7.3). To reduce transport costs for raw material and ensure small crushing operations would remain competitive, however, many oil industry investors also set up their plants in medium-sized urban centers throughout the area of babassu occurrence. For latifundia owners diversifying into agro-industrial investments, the strategy of locating their vegetable oil industries in the vicinity of their local power base also helped to ensure social and political accommodation to their needs.

Firm Scale

The babassu industry's organization may be described in terms of three scale groupings reflecting crushing capacity, technology, and production efficiency. Kernel crushing

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[6] There is a fundamental conflict between the interests of the kernel extractors and representatives of their product market. First, the southern soaps and edible oil manufacturers allied themselves with the kernel merchants so as to assure available domestic supplies of lauric oilseeds. On the other hand, it behooves the babassu oil extractor to be able to export oil whenever the foreign market opens up. It is in the national interest to finance and stimulate export production, but inimical to domestic industry to allow external leakage of strategic products such as babassu oil. More will be said regarding this issue in the section of this chapter dealing with market conditions.

capacity was distributed among a sample of 33 babassu oil factories in Maranhão in 1981, as shown in Table 7.1. Over three-quarters of these firms had crushing capacity less than 68 tons of kernel over a 24-hour period. The remaining 24 percent of firms, each having from 94 to 170 tons daily crushing capacity, produced 56 percent of the oil extracted in 1980-81 (Table 7.2).

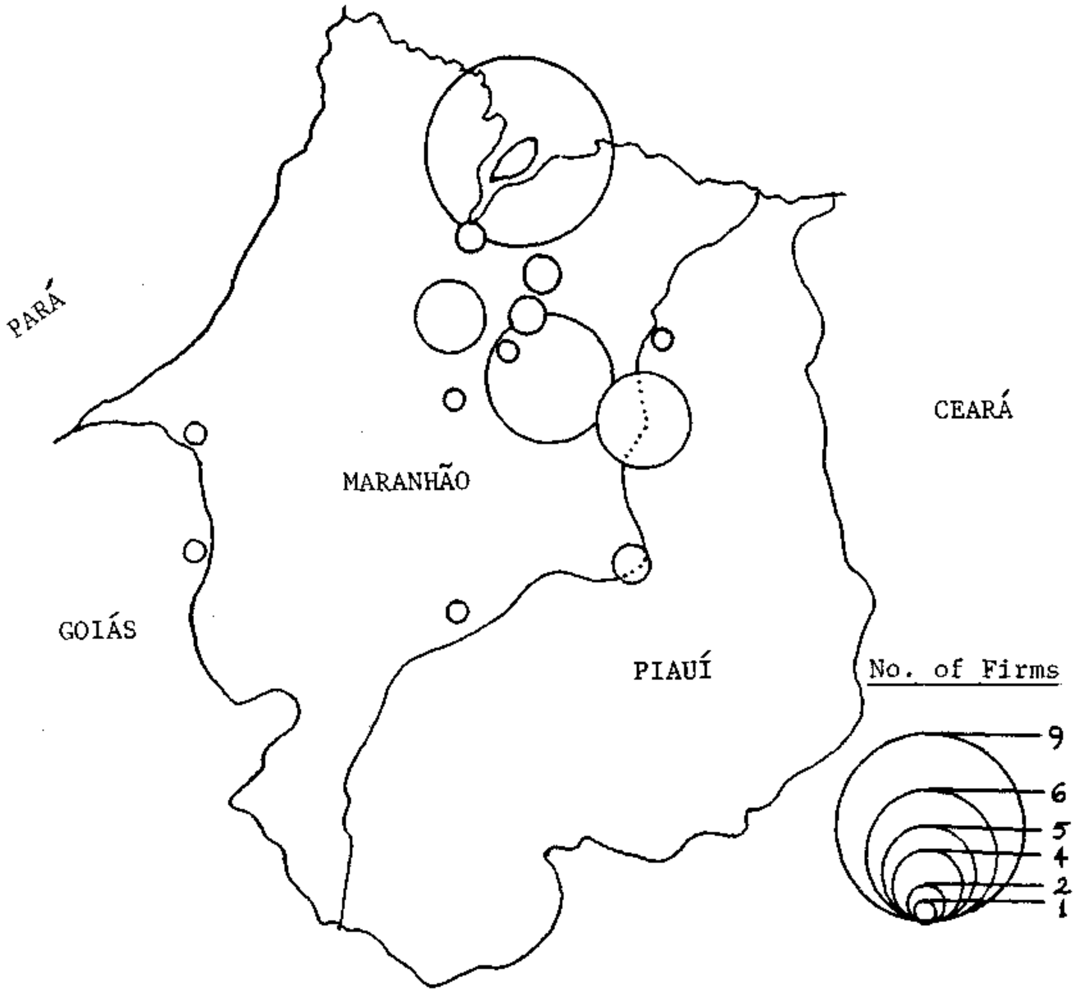

Figure 7.3. Spatial distribution of babassu oil firms, 1981 (Amaral, 1983; field reconnaissance data).

Table 7.1. Scale distribution of babassu oil extractors, Maranhão: 1981 (Amaral, 1983: Tables 37 and 39).

EXTRACTION CAPACITY[a] (tons/24 hrs.)	SHARE OF STATE CAPACITY (%)	FIRMS No.	FIRMS %	AVERAGE CAPACITY[b] (tons/24 hrs.)	AVG. NUMBER OF WORKERS	AVG. CAPACITY PER WORKER (tons/24 hrs.)
18 - 30	10	9	27	23.6	17.9	1.3
38 - 68	42	16	49	54.3	18.1	3.0
94 - 170	48	8	24	126.0	22.5	5.6
TOTAL/AVERAGE	100	33	100	59.5	19.0	3.1

[a] Based on oil production capacity in kernel equivalent (at average conversion rate of 53% oil; extraction efficiency higher in technically advanced factories; lower in expelling system).

[b] Kernel-equivalent capacity in 24 hours, assuming 300-day potential operations.

Table 7.2. Actual oil production and efficiency by plant scale, babassu oil extractors, Maranhão: 1980-81 (Amaral, 1983: Tables 37 and 39).

EXTRACTION CAPACITY (tons/24 hrs.)	OIL PRODUCED 1980-81 (tons)	(%)	CAPACITY IDLE IN 1980-81[a] (%)	DIRECT EMPLOYMENT, 1980-81[b] (man-years)	OIL PRODUCED PER MAN-YEAR (tons)
18 - 30	20,200	16	40	67	301.5
38 - 68	18,600	28	87	28	664.3
94 - 170	36,700	56	77	38	965.8
TOTAL/AVERAGE	65,500	100	79	133	492.5

[a] Based on 300-day potential operation per year; 53% oil extraction rate.

[b] Direct production employment in firms in operation during 1980-81, based on full production labor complement multiplied by capacity utilization rate. Does not include equipment maintenance or plant operations personnel retained during off-season.

The majority of equipment employed in kernel oil extraction is small in capacity; producers simply activate an additional press when volume increases. As a business expands, the tendency is thus to increase the number of presses rather than alter technology. Contraction in raw material supply or demand for oil is accommodated by shutting down a portion of the plant and laying off workers. Employment in the industry is therefore directly linked to oil output.

There are, however, distinct returns to scale demonstrated by an increase with plant scale in both crushing capacity per man-year (Table 7.1) and actual oil output per man-year (Table 7.2). These gains in plant efficiency are for the most part derived from shifts in production technology as plant scale increases.

A number of firms took advantage of capital surplus in the national economy during the 1970s to increase their oil output by augmenting the capacity of their oil presses and incorporating solvent oil extraction facilities to remove the remaining oil from the press cake. Of 34 babassu kernel crushing firms surveyed in 1981 in Maranhão, over one-quarter employed solvents (Amaral, 1983; Table 7.3), while this process was not in use in the babassu industry in the early 1970s (Leal et al., 1972). One of the largest firms has installed a continuous solvent extraction system for direct oil recovery from the kernels. The combined output of both types of solvent system accounted for over half of total oil

Table 7.3. Distribution of babassu oil extractors by process technology, Maranhão: 1981 (Amaral, 1983:Tbl. 37).

TECHNOLOGY	FIRMS		OIL EXTRACTED 1980-81	
	No.	%	'000 tons	%
Oil expellers	23	70.5	30.5	46.5
Semi-continuous solvent systems	9	26.4	27.0	41.3
Continuous solvent extraction	1	3.1	8.0	12.2

production in 1981, although they accounted for less than one-third of the firms.

Some of the same firms which had adopted solvent extraction also diversified their product mix into such areas as oil refining and soap manufacture in an effort to achieve greater security against market risks. Of the Maranhão firms surveyed in 1981 by Amaral (1983), 26 percent produced soaps, 12 percent extracted glycerine, 15 percent refined and canned edible oil, and a small proportion produced margarine and shortening. These categories are by no means mutually exclusive; vertically-integrated firms possessing oil refineries are those which can edible oil and also produce margarines and fine soaps, which require refined oil. Glycerine is a by-product of the soap-making process. These firms, tending to be larger in scale, are also more likely to be those which employ a solvent extraction process. Many firms mill rice and engage in other agro-industrial or commercial activities.

Financial indices for 1979 demonstrate that the babassu industry as a whole was roughly comparable with the regional industry averages for all oilseed processors in Northeast Brazil (Table 7.4). However, these average data disguise the general problem of idle capacity and considerable variation between different firms reflecting effects of scale, diversification, and access to working capital and product markets. The impact of scale on financial performance as well as a decreasing idle capacity rate as plant scale increases are also shown in Table 7.4.[7] On most indices, an increase in plant scale appears to be associated with improved financial condition. Firms operating refineries also appear to perform slightly better than nonrefinery operations on some indices.

Diversifying by means of vertical integration or expansion into unrelated product lines as well as expansion in oil crushing scale have been stimulated by federal investment incentives provided through SUDENE and SUDAM.[8] Such incen-

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[7] These figures differ from those obtained by Amaral in 1980, when idle capacity was highest for the middle scale range and lowest for the smallest firms (Table 7.2). The difference in idle capacity estimates between the two data sources may be due to representativity of the respective samples, as well as changes in industrial performance in the year intervening between Amaral's and Salete's surveys. Salete (1982) only interviewed three babassu firms in the smallest size class, while Amaral interviewed nine. The Salete study was done in 1979, while the industry was still growing, while Amaral surveyed the Maranhão firms in 1980, the year that the industry began its latest contraction.

[8] SUDAM, targets tax reinvestment funds and administers credit and tax holiday incentives for industries in the Amazon region. SUDENE performs a similar role in the Northeast. Since Maranhão is split between the Northeast and Amazonian legal territories, industrialists in the state have the opportunity to seek financing from either agency.

Table 7.4. Financial indices of babassu industry performance, Maranhão and Piauí: 1979 (Salete, 1982: Appendices 38, 40, 42, 43).

FINANCIAL INDEX	PLANT CAPACITY (tons/24 hr.)			INDUSTRY AVERAGES			NORTHEAST OIL INDUSTRY
	6-30	36-80	> 80	Refinery	Non-Refin.	Total	
Profitability[a]	2.4%	4.8%	4.0%	3.6%	4.5%	4.2%	4.6%
Return on assets[b]	3.2%	6.6%	6.9%	7.0%	6.0%	6.3%	4.9%
Gross revenue/ total assets	1.7	1.7	3.1	1.7	2.4	2.2	1.5
Gross revenue/ fixed assets	9.6	12.0	5.1	4.3	10.5	8.8	4.0
Financial leverage[c]	41.3%	24.5%	30.4%	23.1%	31.5%	29.1%	28.1%
Percent idle capacity	53.7%	32.7%	27.6%	n.a.	n.a.	33.2%	n.a.
n of sample	3	11	10	7	17	24	85

[a] Net profit after taxes/net revenues.

[b] Net profit after taxes/total assets.

[c] Short- and long-term debt/total liabilities.

tives include either income tax exemption for 10 to 20 years and subsidized interest rates on capital investment or working capital loans.[9] Of firms surveyed in 1981 in Maranhão, nearly one-third obtained 100 percent income tax exemptions. Half of the firms which obtained tax exemptions also benefited from subsidized loans for plant expansion. Another 15 percent of the firms received low-interest financing for expansion projects without obtaining tax abatements (Amaral, 1983). These incentives have contributed to rapid expansion in regional oil extraction capacity.

Growth in the industry stimulated a compensating growth in kernel production, increasing from slightly over 100,000 tons in 1960 to over 250,000 tons in the 1970s. However, the industry has experienced recurrent shifts in demand, a relative stabilization in kernel supply (Figure 7.4), and a high overall idle capacity rate. Only 21 percent of Maranhão's oil extraction capacity was used in 1980-81 (Table 7.2). While studies by SUDENE and other agencies have periodically decried the over-capacity condition of the babassu oil industry (Leal et al., 1972; Salete, 1982), there has been

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9 Such incentives are generally available for agro-industrial investments of regional priority, ie., those which use a local raw material and local labor to produce a product that has either regional or national demand. While these criteria play some role in the ranking of projects for federal support, it is probable that existing firms operating with a reasonable degree of financial health would be able to leverage additional financing for plant expansion or diversification. Since babassu oil extraction was perceived by local investors as a lucrative business proposition, in which many were already involved, application of a large amount of subsidized funding to babassu was a logical outcome.

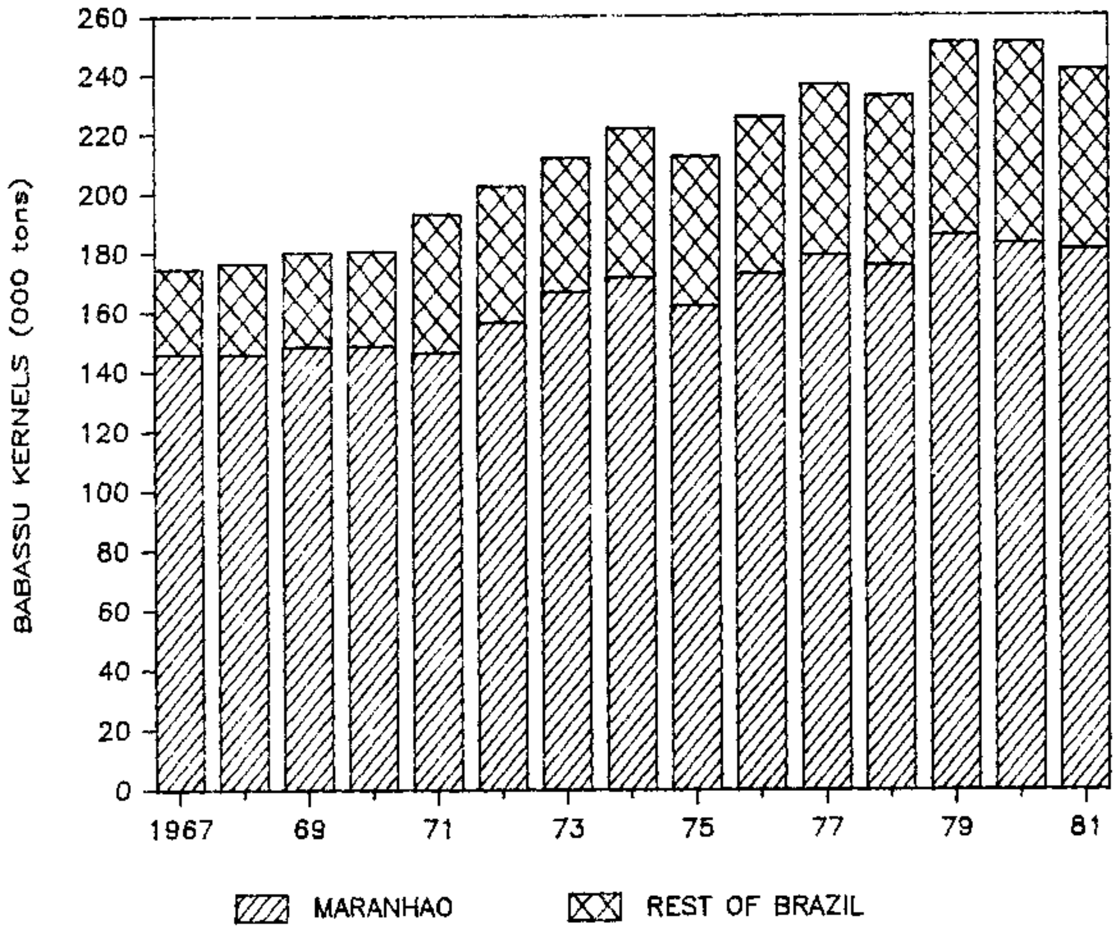

Figure 7.4. Production of babassu kernels in Maranhão and the rest of Brazil: 1967 - 1981 (IBGE, 1984b and previous volumes).

little progress in diverting financing and tax abatements toward alternative industrial investments.

To understand the reasons that regional investors have remained in the babassu business requires a more complete view of the way the industry operates, and how industrialists perceive their raw material supply security as well as the future of their markets. These factors are explored in the next sections.

Oil Extraction Processes

Of the factories in the babassu industry, over 70 percent employ a kernel pressing technology known as oil "expelling" (Table 7.3). Oil expellers are heavy-duty systems that cook hammer-milled kernels under steam pressure and mechanically press the oil-saturated meal. The oil expelled is filtered and stored in tanks. The press cake derived as a by-product of this process, containing about six percent oil, is then bagged for shipment.

Semi-continuous solvent extraction, introduced in the 1960s in Brazil, has made the process more complex (Figure 7.5). This mode of oil extraction employs tanks in which batches of press cake are washed in progressive stages with hexane, which is recycled. This system enables less oil to be expelled in the press stage. For this reason, the expellers employed for semi-continuous solvent extraction need less steam pressure than those used in the more rudimentary expelling process, and are hence lighter-weight machines. The

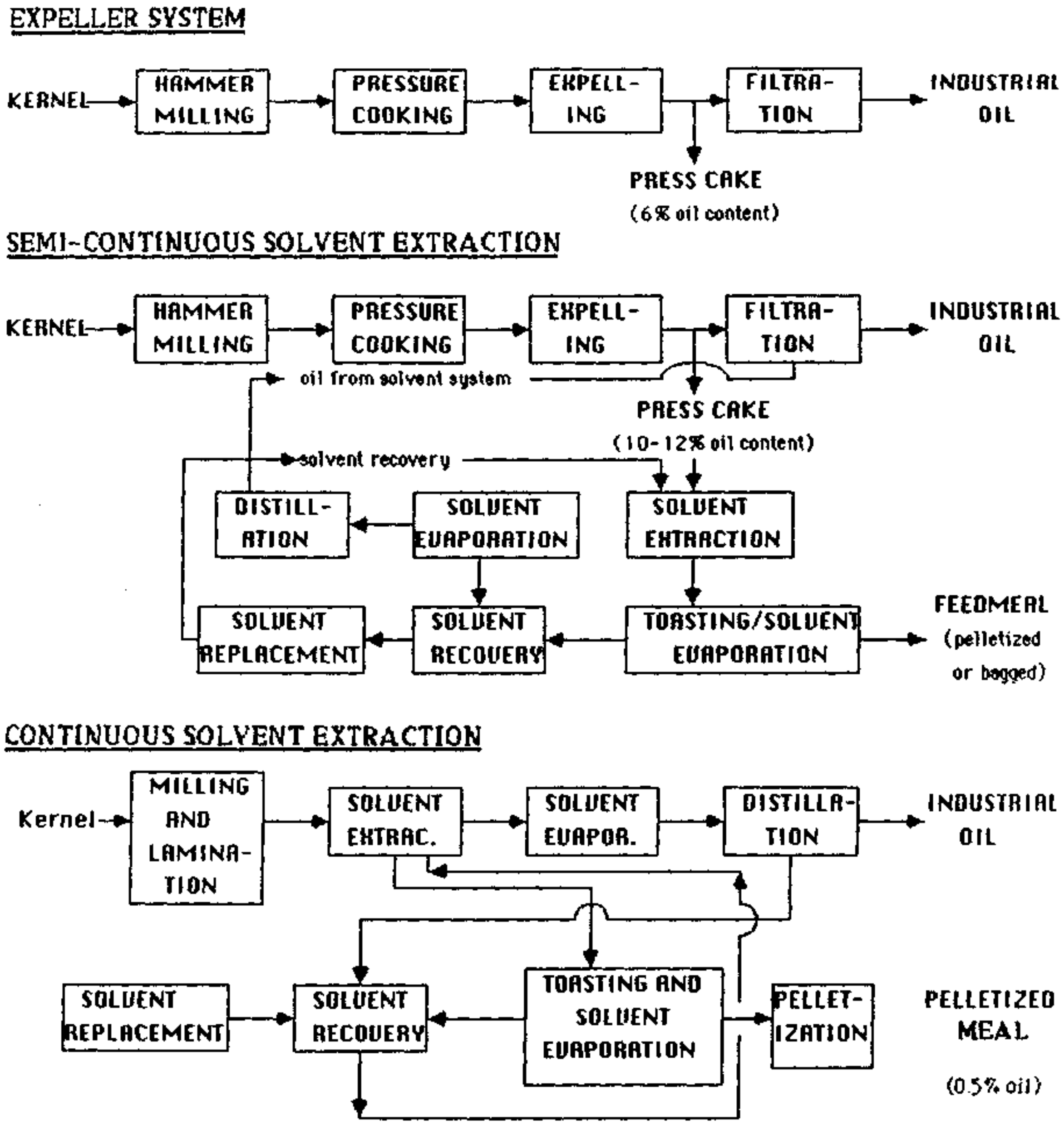

Figure 7.5. Processes of oil extraction in use in the babassu oil industry (Wilson Milfont, personal communication).

press cake derived from the expellers for solvent extraction contains about 11 percent oil; 90 percent of this is extracted with hexane, leaving a meal containing only one percent oil.

Finally, a few firms in the babassu industry have moved toward continuous solvent technology, a method also used in large-scale soybean crushing elsewhere in Brazil. Only one factory in Maranhão (OLEAMA) has installed this system. Continuous solvent extraction avoids the initial stages of hammermilling and pressure cooking. Instead, heavy steel cylinders with evenly-spaced blades press or "laminate" milled oilseeds into thin sheets; these fragments are then immersed in hexane until fully saturated, by circulating the solution ("micella") of oil and solvent among a bank of moving canisters. Through this process, all the economically-extractable oil is removed, leaving less than 0.5 percent oil in the meal. Solvent is continuously recovered from both oil and meal through evaporation and distillation. While the latter technology is far more complex, its users benefit from economies of scale and higher quality products. This accounts for the fact that OLEAMA's production alone accounted for 12.2 percent of oil extracted in 1980-81 in the state (Table 7.3).

Capital Investment and Raw Material Selection

The equipment used in most babassu oil factories is fabricated in Brazil. The vast majority (86 percent of the firms surveyed in 1981 in Maranhão) use presses of the Piratininga and Maseiro lines, produced in the São Paulo area

(Amaral, 1983). Piratininga equipment is also that most frequently employed in semi-continuous solvent extraction. However, the only firm that fabricates continuous solvent extraction systems for babassu kernel oil in Brazil is De Smett, a Belgian firm whose Brazilian subsidiary is headquartered in São Paulo.

The average age of the presses in use in Maranhão as of 1983 was 13.3 years.[10] Nearly two-thirds of all equipment was purchased between 1960 and 1972. However, fully 16 percent of all presses were acquired in 1979 alone, and 31 percent were installed in the last five years of the past decade (Amaral, 1983). These installations consisted mainly of solvent extraction equipment acquired during the heyday of federally-subsidized plant investment in the babassu industry. Such equipment now has an average age of only 5.5 years.

The combination of fully depreciated equipment in the older plants and government subsidized investment in replacement machinery results in minimal capital amortization expense being accrued by the existing industry as a component of fixed costs. This is reflected in an extremely high ratio of gross revenues to fixed assets net of depreciation in the unrefined

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[10] This figure was calculated on the basis of year-of-purchase data for equipment in use by firms surveyed in 1981 (Amaral, 1983). The calculation assumes that no additional installations were made from 1981-83 and that all equipment was purchased new at date of acquisition, which is extremely unlikely given the ready market for used and refurbished equipment. The combination of new equipment purchases in the years since the survey, and the probability that at least some of the reported equipment was purchased second-hand, would be likely to balance-out the average age to some extent, so the reported average age is probably near correct.

babassu oil industry,[11] and an average of only five percent of revenues going to debt retirement in the babassu industry as a whole in 1979, despite major plant expansion in that year.

The different technologies in use by the babassu industry require different levels of management, engineering skill, and capital at the outset, corresponding with different scales. The larger and more technically-advanced firms are among those in better shape financially today, and whose bonds to babassu as a raw material are weakest — hence, they may be designated "vegetable oil producers." This is so because solvent extraction technology is more flexible with respect to the type of raw material used. Babassu kernel requires considerably more solvent than other oilseeds (e.g., soybeans and cottonseed) for an equivalent batch size. This is so because the other oilseeds contain less oil. However, their by-product meals are important contributors to industrial revenue. As the cost of hexane (a petroleum derivative) increases, therefore, those producers who are flexible would be motivated to actively move toward alternative oilseeds if they become available at competitive cost.

Furthermore, larger firms have commensurately larger raw material demands; their capital costs and other fixed costs (maintenance, taxes, insurance and, in some instances, labor) require that they operate during as much of the year as

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[11] The average ratio of gross revenue to net fixed assets was 10.5 in the babassu industry (non-refining segment) versus 4.0 for the Northeast Brazilian vegetable oil industry as a whole in 1979-80 (Salete, 1982). See Table 7.4.

possible to assure a satisfactory return on their investment. Babassu's seasonality, causing difficulties in securing an adequate volume during part of the year, make economical alternatives or supplementary sources attractive.

In contrast, the smaller firms in the babassu oil business appear to have a greater stake in babassu kernel as a raw material. Therefore, they may be designated "babassu oil processors." These smaller operations often control a good share of their supplies on their own properties, and press the kernels with obsolete aging equipment. For the latter reason, they are under little financial pressure from fixed expenses, and can easily shut their doors for the six-month period between babassu harvests.

For these reasons, there is a different perspective on the aims and future of the industry shared by those who regard themselves as "babassu oil processors" versus those who see themselves as "vegetable oil processors." Among the latter, there have been some recent efforts to diversify oilseed use. Such diversification has been limited to larger firms, primarily those which, besides expelling oil, also produce refined oil for edible purposes. The other oilseeds purchased by such firms, still in relatively small volume and primarily during the period between babassu harvests, include dende (African palm) kernels, tucum (another native lauric oil palm), cottonseed and, more recently, soybeans.

Although babassu kernels remain the predominant raw material in use by these firms, there is hope that more wide-scale planting of tropically-adapted soybeans in Maranhão will contribute increasingly to capacity utilization. Soybeans represent the major source of edible oils and feedmeals produced in Brazil; the meteoric rise in the nation's production since the 1970s has made Brazil the world's largest exporter and the second-largest producer of soybeans. A range of government incentives have promoted this growth, which has been confined principally to the southern states. However, recent development of tropically-adapted soybeans promises to allow expansion in the area cultivated to the babassu zone.[12] Ideally, it appears that the two oilseeds would complement one another, since they are not direct market substitutes, and the soybean harvest arrives during the idle season in the babassu kernel harvest. However, the problem appears to be one of assuring that those firms interested in diversifying oilseed use can survive the necessary transition period for soybeans to be adopted as a crop. The economic

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[12] Soybeans are now being planted with promising results in Maranhão. OLEAMA, the largest babassu oil extracting firm, has contracted with growers who have recently immigrated to southern Maranhão from agricultural areas in the south of Brazil to produce soybeans for the firm's continuous solvent system. These will supplement and gradually supplant at lower transport cost soybean supplies from central and southern Brazil which OLEAMA already uses to make edible oil for the regional market. As described briefly in Chapter IV, one of the larger oil firms in Caxias has begun to integrate vertically with a soybean agribusiness operation planned to produce both seed for other regional growers, and a steady internal supply to the firm. Neither the Caxias firm or OLEAMA are expected to relinquish babassu kernel as their predominant raw material, however, because both firms also produce soaps and refined oil products which require lauric oil content.

crisis of the early 1980s brought with it considerable adjustment in the babassu industry.

To be sure, this adjustment has by no means paralyzed the industry. Although the national economic crisis has caused a recession in final demand for soaps and cosmetics, and many babassu extractors were forced to idle their operations as a consequence, several firms have invested in new equipment since the onset of the crisis. One firm was taken over by another seeking to expand overall holdings, and there is a general feeling among entrepreneurs that the industry's market share is expansionary. This viewpoint hinges on babassu kernel's uniqueness as a raw material, and depends ultimately on the maintenance of both secure supplies and restricted access to the Brazilian market for cheaper substitutes.

Security in raw material supply, one of these critical elements, ultimately depends on landowners' decisions vis-à-vis babassu stands on their properties. To grasp the landowner's perspective on the desirability of retaining palms, it is first necessary to understand the evolution of and trends in price formation for babassu kernels. In the next section, I trace the path of kernel marketing from the producer to the final consumer of industrial oil, to gauge the distribution of benefits from babassu extraction in its current form.

Raw Material Supply Networks

Importance of Kernel Supply to the Oil Industry

The principal component of direct production costs in the babassu oil industry consists of working capital outlays for raw material. Kernel supply costs accounted for 86 percent of the cost of goods produced by a sample of 24 oil extractors in the babassu zone in 1979 and nearly 62 percent of their total gross revenues (Salete, 1982; Table 7.5). While the oil extracting firms directly employed some 950 workers and administrative staff in Maranhão in 1980-81 (Amaral, 1983), these labor costs were insignificant when measured against those of raw material supply. The rural population indirectly employed as suppliers of kernel to the industry far exceeds direct employment at the plant.

Babassu kernel is furnished to oil extractors from distant stands by fruit breakers working as individual family units, marketing their output through a complex network of intermediaries. It has been estimated that over 300,000 households are engaged to some extent in babassu kernel production in Maranhão alone (Kono, 1976) and over 420,000 in Brazil as a whole (Mattar, 1979). Each such household usually has more than one person active in babassu harvesting and kernel extraction, so that the number of persons employed may be as many as double the number of households.[13] The geographic spread of palms stands, the complex of property rights

[13] Mattar (1979) estimates that 2.1 persons per household are engaged in gathering and breaking babassu fruit.

Table 7.5. Operating statement of babassu oil firms, sector average: 1979 (FTI, 1982: 4-51).

ITEM	'000 US$ (1979) (per firm)	%
Gross revenues (net of adjustments)	**$ 5,013.0**	**100.0**
Production costs		
Raw materials	3,085.2	61.5
Labor	70.7	1.4
Intermediate matls.	241.9	4.8
Other	174.9	3.5
Subtotal	$ 3,572.7	71.3
Additional costs[a]	539.6	10.8
Cost of goods sold	**$ 4,112.3**	**82.1**
Administration and marketing	350.8	7.0
Financial expense	268.0	5.3
Other costs	81.9	1.6
Total expenses	**$ 4,813.0**	**96.0**
Net operating revenue	200.0	4.0
Non-operating revenue	70.7	1.4
Total Net Revenue Before Taxes	**$ 270.7**	**5.4**

[a] Inventory change and cost of other goods marketed.

through which producers obtain access to stands, and the sheer immensity of the population involved in extraction of babassu as a complement to shifting cultivation and other activities make this network impossible to control centrally.

The industry's principal link with raw material producers is through large regional merchant firms.[14] Each kernel merchant operates a fleet of trucks whose drivers serve as decentralized buyers. The merchants generate their supplies by maintaining a broad network of landowners and store-keepers who buy or trade kernels extracted from both their own properties and neighboring areas. The large merchants who buy babassu kernels are also often those who finance storekeepers' commercial operations in the babassu zone, by advancing commodities on credit. The storekeepers in turn buy kernels from fruit collectors in exchange for these products.[15]

Part of the complexity in assessing the conditions of and prospects for the babassu industry arises from difficulty in identifying who is a "producer" of kernel. The price at which

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[14] Two firms interviewed by Salete (1982) obtained 60 to 70 percent of their kernel from merchants, while one obtained them principally (80 percent) from large landowners. Oil extractors prefer to buy in large lots and reduce the number of their raw material transactions to a minimum. A price premium and working capital advances at no interest are the usual incentives provided to large suppliers.

[15] Prices for goods exchanged for babassu kernels in local stores are often considerably higher than those in municipal centers, reflecting both transport costs and intermediary profit-taking on exchange and extension of credit. Among the farms I surveyed, storekeepers reported average profits of 16 percent on retail sales. Informal credit terms further depress the real terms of trade between kernels and wage goods received in exchange by producer households.

the landowner or storekeeper sells kernels to the merchant is the "producer" price used for calculation of value-added taxation. Yet, there is invariably at least one initial transaction before this "producer" price is reached. Confusion on this issue has extended to the provision of credit in anticipation of harvest to "producers" who were, in fact, landowners or renters of babassu stands who used the credit to purchase kernel extracted by peasants, profiting from a transaction in which they made no direct investment.[16] For the purposes of the discussion below, the "producer" of babassu is considered to be the person whose labor is employed in gathering babassu fruit and/or extracting kernels. Because the industry is often many levels removed from the producer, the kernel marketing chain is an important aspect to consider in gauging the industry's raw material supply situation.

The industry must secure its kernel supplies in most cases by advance payment to suppliers. The barter system involving trade of babassu kernels for food and other consumption goods requires that capital be available to initiate the process. In the past, working capital surpluses sufficient to initiate kernel purchasing have been generated by merchants involved in resale of rice, since the rice harvest closely precedes the initiation of the babassu fruit harvest. However, Amaral (1983) suggests that with development of the

[16] Commission for Production Financing (CFP) personnel are cited as being unable to provide floor price financing for babassu kernel production because it is impossible to determine who is the "producer" (FTI, 1982).

local oil extraction industry, working capital now originates with the industry itself, rather than from surpluses held by raw material suppliers. The extension of working capital through the supply network represents a financial burden which is reflected in the overall costs of babassu oil production. One major solvent extracting firm, in its balance sheets for the period 1975 to 1979, showed an average of over 50 percent of current assets tied up in formation of raw material stocks, of which nearly one-quarter consisted of advances to suppliers (Banco de Desenvolvimento do Maranhão, 1980).

The problem of securing sufficient working capital to start and maintain kernel supply is closely linked to industrial capacity expansion and historical underutilization (Salete, 1982). Industrialists expand their oil extraction capacity to be able to handle peak kernel flows quickly, so that working capital can be recycled into the supply chain to expand a firm's purchasing power. They are able to stock oil easier and with less quality deterioration than that experienced with kernels, which represents an added incentive to convert raw material quickly into oil and feed. The ease of availability of equipment investment financing as well as its lower interest rates and longer repayment terms than those for working capital have made such investments attractive.

In Maranhão, the installed kernel oil extraction capacity actually exceeds the total raw material production potential of the state, of which only one-third is currently marketed.[17] The long-term growth in kernel production was accompanied by industrial capacity growing at approximately the same rate. Thus, it is no surprise that the industry has historically shown an idle capacity that has remained stable at about 75 percent.

Factors Influencing Kernel Production

Supply of kernel more than doubled from the time the oil extraction industry began its local expansion during the 1960s. A rough estimate of kernel supply available to operating firms in Maranhão and Piaui shows an increase from an average of about 1,100 tons per firm from 1940 through 1961, doubling by 1967 to nearly 2,200 tons. By 1980, the kernel production per operating firm in Maranhão had leapt to nearly 5,500 tons, reflecting increases in both plant capacity and kernel output.

Raw material supply was enhanced by an increase in rural population, in the area under shifting cultivation, and in fruit extraction rates. These interrelated factors have resulted in more land being colonized by babassu palms and more fruit being collected for kernel extraction.

Intensification of harvesting in areas of fairly long-term human occupation appears to represent the major variable

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[17] Calculations are based on satellite inventories of babassu stands and ground truth on average sub-regional stand productivity (MIC/STI, 1982) confronted with annual kernel marketing figures (IBGE, 1984b). See Table 3.8.

explaining output growth. The average kernel production per rural inhabitant in Maranhão more than quadrupled from an average of 15.3 kg. per year in the period between 1920 and 1935 to 66.8 kg. between 1965 and 1980. Figure 7.6 exhibits three phases through which kernel output passed. The first, between 1920 and 1935, corresponds with babassu's dominance as an export product. The second, from 1940 to 1960, is the period when babassu oil was mostly extracted in southern Brazil. The most recent period corresponds with the expansion of the oil industry in the babassu zone itself. This increase in babassu harvesting intensity is also traced to expansion in oil product markets as a result of economic development and population growth in Brazil as a whole. The effect of all these factors was to increase the local price of kernels, making babassu harvesting a more attractive activity for the landowners, who came to rely on babassu for an increasing share of their farm revenues during the 1960s (see Chapter IV).

Although the general historical trend has been positive, industrialists complain that supplies have become more difficult to secure. This they blame on continuing deforestation of babassu to make way for improved pastures and sugarcane in areas where the palm is most accessible for harvest and where it occurs naturally in highest densities (see Chapter VI). Merchants and industrialists assert that deforestation increases costs of raw material transport, because buyers must range further afield to secure supplies. Other reasons given

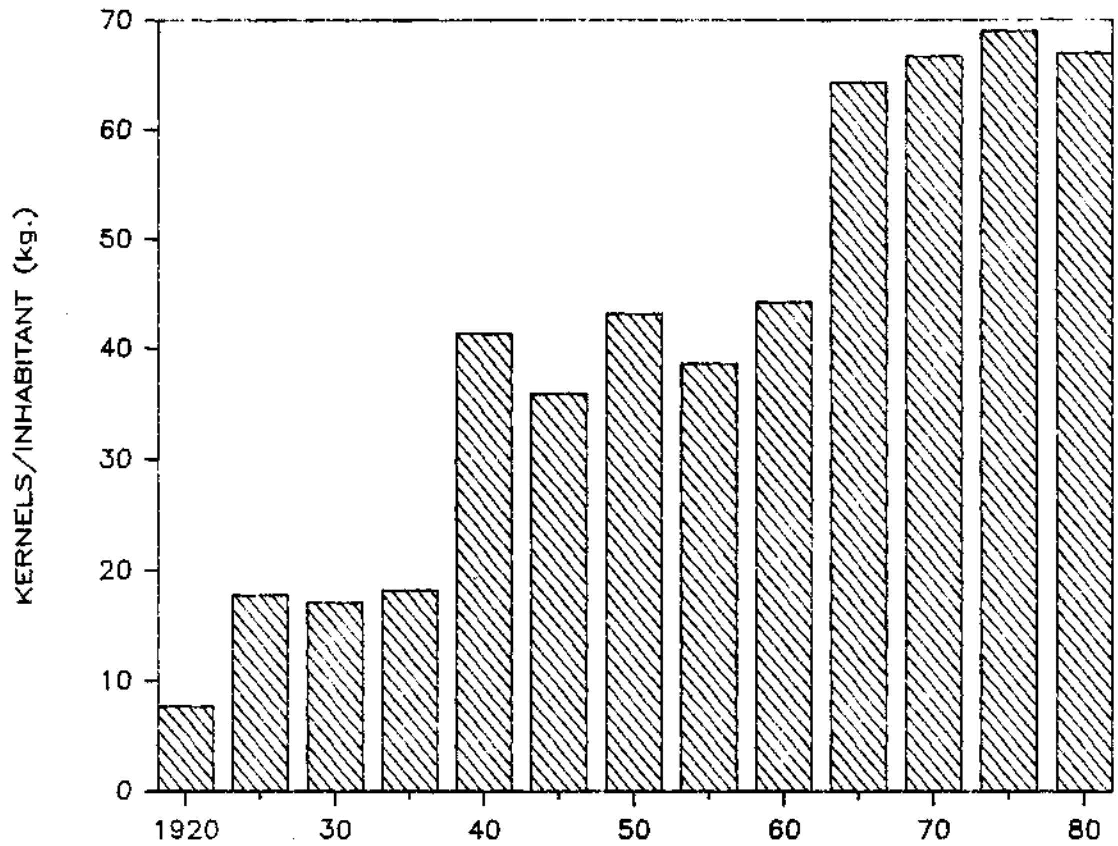

Figure 7.6. Babassu kernels marketed per rural inhabitant, Maranhão: 1920 - 1980. Data are 5-year moving averages (IBGE, 1984b and previous volumes).

for difficulties in obtaining raw material for the local industry include increasing flows of kernel to other states outside the babassu zone,[18] and competition of other activities for rural labor.

It is not clear from the previously described production statistics that supplies available locally have in fact declined, as industrialists assert. The long-run trend in kernel output has been positive, despite some slight stabilization since 1978 (Figure 7.4). Their over-investment in oil extraction capacity during the rapid growth period of the early 1970s may explain why a stabilization in kernel output would be viewed with dismay. Efforts to use plants to capacity during the peak harvest period would tend to heighten supply competition. But heightened demand for raw materials would tend to result in better producer prices. Producers would then be anticipated to increase extraction rates to compensate. In counter-argument, industrialists claim that peasants are not motivated by increased prices to extract more babassu. In fact they assert that peasants may reduce their efforts in this direction because they would be able to provide enough of their cash needs with less work.

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[18] To make such "leakage" less lucrative for merchants, the industrial organization was able to secure preferential rates of value-added taxation for kernels marketed within the state of Maranhão rather than sold to firms in other states. However, this tactic has been fairly ineffectual, since a good share of kernels are marketed so as to avoid payment of any such taxes through a variety of devious means reported to me by an industry trucker. One way is to bribe the county fiscal officer to approve a bill of lading for a quantity of kernels less than that actually being transported. Another is to avoid stopping at the fiscal station entirely.

This argument appears more a self-serving proposition than one that would contradict the conclusion I have reached from reviewing the history of growth in peasant babassu extraction rates. Since the local development of the babassu industry, peasants have been motivated to increase their kernel production rates considerably (Figure 7.6). Thus, local demand for kernel has had a significant effect on peasant behavior. If industrialists were correct in their characterization, peasants would produce according to a backward-bending supply curve: the more you pay, the less they supply. The increased output per-capita would then have to mean the inverse: the industry is paying less, therefore, peasants are supplying more. This analysis tends to oversimplify the situation, however, leaving out other important actors.

In delimiting peasants' freedom to gain access to and market babassu products, landowners' decisions critically affect supply of kernel to the industry. At root, the future of the industry thus appears to lie in the interaction between landowner decisions and peasant labor allocation. The distribution of returns from kernel marketing at different levels in the chain is an important factor affecting this interaction, as is described in the next section.

Price Formation Along the Kernel Marketing Chain

As was demonstrated in Chapter V, babassu kernel production and peasants' use of other palm products represent an integral part of the rural economy. Babassu kernel sale is one of few available cash-generating options for the peasantry of the babassu zone during the period between annual crop harvests. Supply thus appears to respond fairly consistently with the degree to which kernel extractivism complements the peasant's lifestyle and economic opportunities. When the production relations around which these strategies are built begin to collapse, the ability of kernel sales to fulfill their customary place in the household economy is threatened. Labor will be allocated in different ways.

As was described for the case of Caxias in Chapter IV, babassu producers formerly lived on remote isolated farms or state lands. Their atomism as production-consumption units has been progressively modified with the onset of agrarian change. In the past, landowners and merchants penetrating the subsistence economy were able to set kernel prices fairly arbitrarily, paying a smaller share of the industry's purchase price to the producer than they do today. This situation was attenuated somewhat by the opening of transport corridors and lines of communication between urban and rural areas.

There are several alternate paths through which kernels are marketed. In rare cases, fruit collectors sell kernels directly to an industry or merchant/trucker. In the majority of cases, however, there are at least two intermediary levels in the marketing chain: the kernels are purchased by a storekeeper, resold to a merchant/trucker, and finally to the industry. In most cases, an additional link is added by the

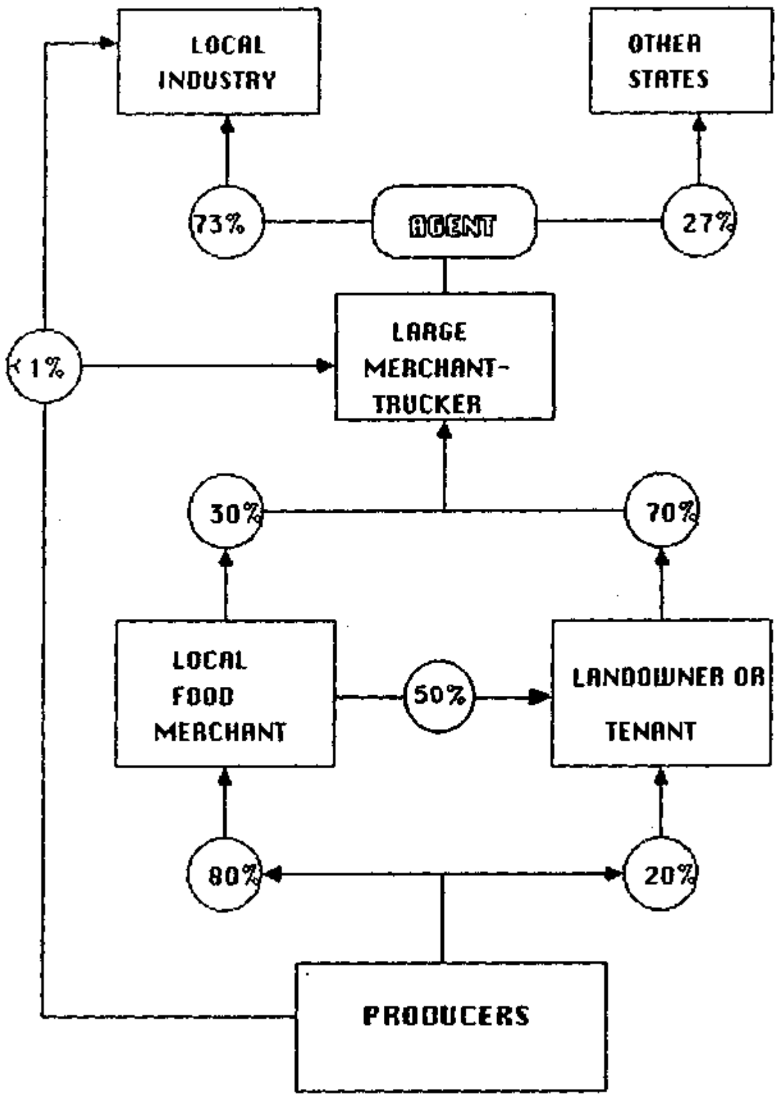

Figure 7.7. Intermediary structure of babassu kernel marketing in Maranhão (adapted from Mendes, 1979).

landowner, who pays a kernel-purchasing agent or storekeeper a percentage of the proceeds and/or allows him to plant crops or keep livestock on the property. The landowner then sells the kernels to the merchant/trucker. Another level may be added between the merchant and the industry in the form of an agent who lines up the sale and arranges for kernels to arrive at the plant, receiving a commission (Figure 7.7).

An increase in the number of intermediary links effects a reduction in the share of the industry's purchase price received by the kernel producer and is widely considered to be a principal factor contributing to the costliness of the raw material. The degree of market integration achieved during the past decades has apparently improved the bargaining position of the peasantry with respect to their share of the proceeds from the industry. A comparison of data from the farm-level surveys conducted for this study with that from earlier research illustrates this point.

Braga and Dias (1968) found that producers received only 45 percent of the industry buying price in the mid-1960s, resulting in higher margins for intermediaries than those I found in my surveys.[19] Surveys in the 1970s by FAO (1974) and Mendes (in CEPA-MA, 1981) report results similar to those I obtained (Table 7.6). The price paid to producers in Chapa-

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[19] There is a severe paucity of information available on the historical distribution of returns from kernel marketing. The only other data discovered referring to marketing margins was a figure of 20 percent for landowners' resale to merchants provided by Valverde (1957), information he obtained from a "reliable" large landowner in Paiuí.

dinha between October, 1983 and May, 1984 averaged 61 percent of that paid by the industry, when weighted by the proportion of kernels sold monthly. The weighted gross margins on resale by landowners and storekeepers to large kernel merchants averaged 25 percent, while gross margins at the final leg in the kernel marketing chain were only 17.5 percent.[20]

Considerable variations are to be found in price policies at the level of the individual landholding. I discovered an average monthly range of 53 percent from the low to high prices paid for kernel between properties within the Chapadinha survey area. Prices in Chapadinha averaged somewhat higher than those in Lima Campos,[21] but varied over twice as widely (Figure 7.8). This variation could be due in part to the

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[20] This figure refers to cases in which the landowner or storekeeper transports the kernels to the large merchant's warehouse. Often, however, large merchants dispatch their trucks to receive kernel at the farm store, in which case the landowner saves on his own transport costs, but receives a reduced gross margin. Gross margin is calculated as the difference between purchase and sales price over the sales price. This calculation describes the share of resale prices that make up the intermediary's gross revenue, while the percent distribution, based on the share of the final sale price which accrues at each link in the marketing chain, is not appropriate for calculation of profit.

[21] The difference between prices in the two areas ranged 10 percent on either side at different points in the year. While prices were slightly higher in Lima Campos during the peak of the harvest, they stayed higher for a longer period in Chapadinha. This probably reflects what industrialists told me is the higher kernel quality from Chapadinha producers, who extract more kernels without breaking them or leaving pieces of shell attached to them, both of which affect oil extraction rates and quality. Kernel from the area around Chapdinha is therefore preferred by oil extractors and fetches somewhat higher prices.

Table 7.6. Historical marketing margins for babassu kernels (sources in table).

SOURCE	PRODUCER[a]	LANDOWNER-STOREKEEPER[b]	MERCHANT[b]
Valverde (1957)	n.a.	20%	n.a.
Nicholls & Paiva (1966)	n.a.	36 - 50%	n.a.
Braga & Dias (1969)	45%	42%	22%
FAO (1974)	50 - 70%	7 - 33%	10 - 38%
Mendes (1978)	42 - 55%	21 - 40%	31%[c]
FTI (1982)	43 - 63%	26 - 50%[d]	14 - 25%
May (1983-1984) average[e]:	61%	25%	17.5%
range:	46 - 73%	9 - 44%	2 - 35%

[a] Percent of final industry purchase price (equivalent to merchant's sale price).

[b] Gross margin = (sale price - purchase price)/sale price.

[c] Based on range of prices offered by oil firms in São Luis in February, 1978.

[d] Latter margin (50%) was divided equally between a stand renter and a landowner.

[e] Weighted by the share of kernels marketed each month by respondents.

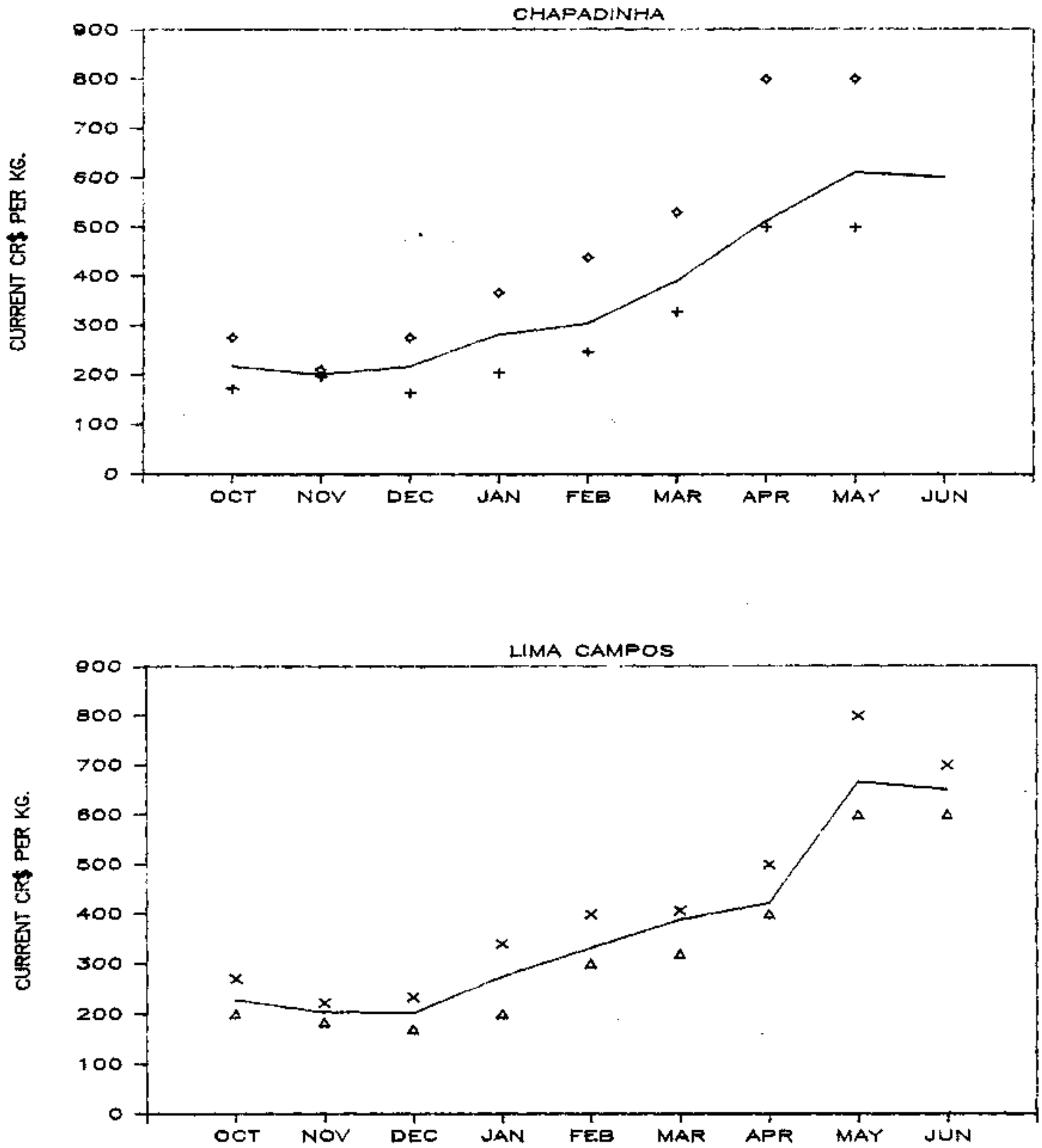

Figure 7.8. Kernel producer prices, Chapadinha and Lima Campos, Maranhão: October - June, 1983-84.

greater isolation of some estates in Chapadinha from market information or access.

Despite the generalized prohibition against kernel marketing off the premises, respondents in the cocais agreed that collectors are motivated to carry kernels they extract off the property to sell elsewhere, even at only slightly better prices. Threat of expulsion is the principal sanction against moradores selling to other kernel buyers. Such coercion seems much more effective in the cerrado. There, distance to paved roads and between rural stores tends to be greater than in other areas. Traditional landowners in the cerrado tend to collude in prohibiting "leakage" of extractive products which constitute a greater share of their farms' revenues than is true in the cocais. Most landowners interviewed in the cerrado said that they would "call attention" to a morador's transgression from the residence contract, with a repeated offense being grounds for expulsion.

Harvest seasonality also influences kernel supply and pricing and hence individual returns. The seasonality of kernel production, corresponding to fruiting and harvest cycles, confers some discontinuity on industrial operations (Figure 7.9). Babassu fruit begin to mature and fall from the bunch starting in July and August. Gathering and kernel extraction are concentrated in the six-month period between October and March. It is clear from the bottom graph in Figure 7.9, however, that a few firms are able to maintain some level of supply nearly year-long.

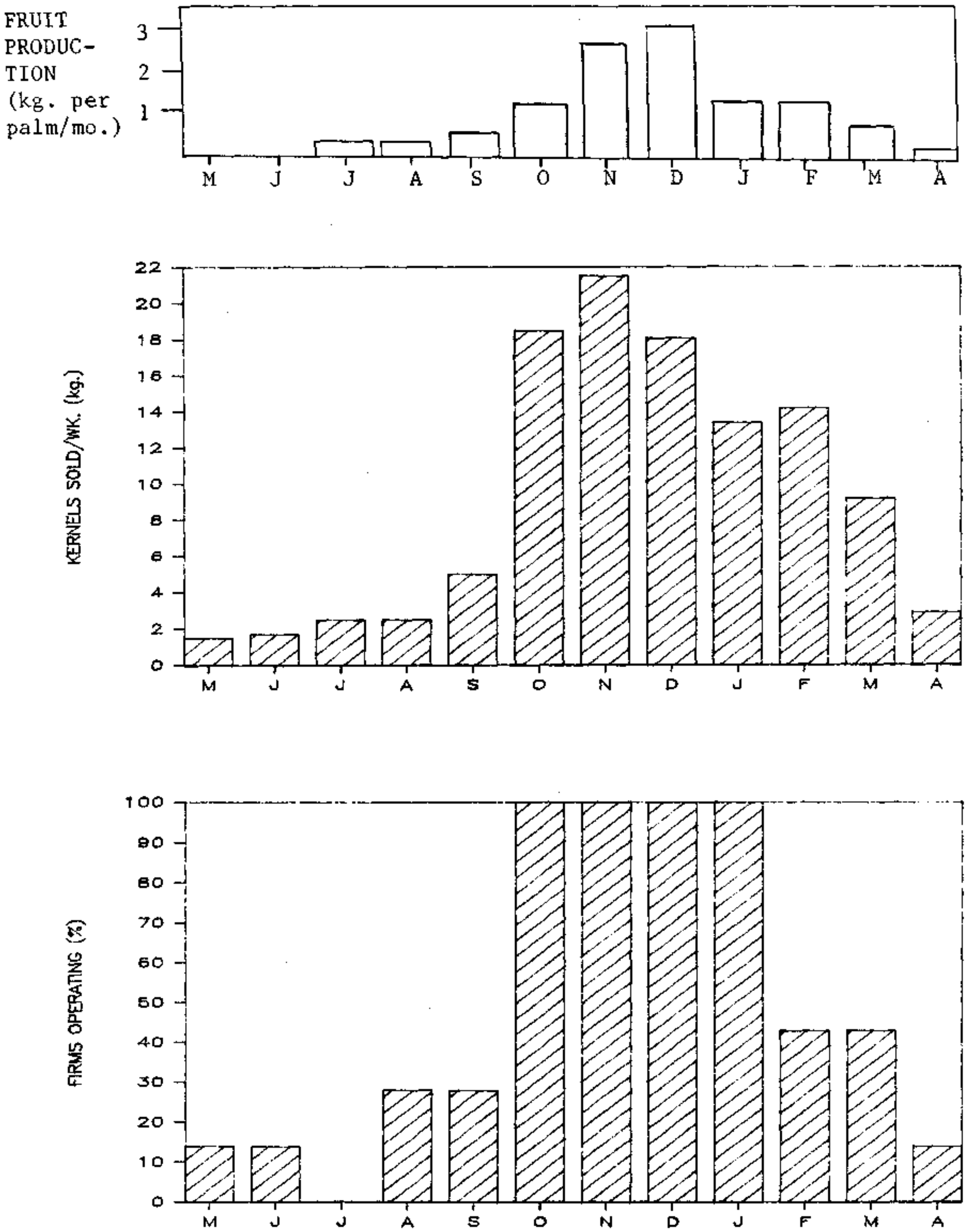

Figure 7.9. Monthly fruit production per palm, kernels sold by producers, and proportion of firms reporting activity at or near capacity. Fruit production figure is from Anderson (1983). July-Sept. kernel sales are estimates by producers.

Seasonal price relationships reflect the pattern of supply. Although some firms close down at the end of the peak harvest period, competition between firms remaining in operation for the reduced raw material supply tends to push prices upward. A comparison of industry purchase prices between the beginning of the harvest in October and its tail end in May over the period 1973 to 1984 reveals that there were real kernel price increases between October and May in most years, (Table 7.7). As the harvest cycle begins anew in August and September and idle plants resume operations, there may be a brief spurt of even higher prices, but these tend to flatten out or actually decline — as they did in 1983 — as the harvest begins to generate new supplies.

Prices for kernel increased rapidly in the survey year after this initial stabilization due to scarcities in foreign markets which allowed oil extractors to export a fair share of their overall production. The shortfall in oil supply to serve domestic demand placed a strong upward pressure on internal oil prices, as occurred ten years previously during a similar export market opening (Table 7.7). Kernel producer prices also increased dramatically, more than doubling in real terms when deflated by the index of local food prices in Lima Campos between October and May. The increase in real kernel value was not as dramatic in Chapadinha, due to rapid inflation in basic food prices as a result of the prior year's drought (Figure 7.10).

The effect on producer prices of these oil price increases was considerably lagged. While the industry's buying price for kernel increased substantially in real terms as early as December, a matching response in local producer prices only began to take hold in February. By this time, producers had already sold over 70 percent of the total volume of kernels they reported extracting from October to May. By March, peasant families were already devoting more of their total time to weeding and preparing for the coming rice harvest than to gathering babassu fruit (Figure 5.4.a).

The price increase failed to stimulate a marked increase in output among producers in the survey. Although there was a slight increase in February over January kernel sales (Figure 7.9), this appears to have been more a result of the freeing up of labor after the first weeding of the roça than a response to price increases. A similar rise in kernel output has been observed for other years in which price increases were less notable (Anderson & Anderson, 1983; Leal et al., 1972).

Output in April through June was negligible despite the continuing increase in real prices. It appears that the lion's share of the increased returns from the price hike were shared among merchants and landowners rather than filtering down to the producer level. Peasants would have benefited if the prices they received reflected the industry's increased purchase price early enough in the harvest season. By the time local prices increased, most babassu had already been harvested, and peasants were far more concerned with the rice

Table 7.7. Seasonal fluctuation in price of babassu kernels, placed at the plant in São Luís (1973-77 from Mendes, 1979; 1977-81 from FTI, 1982; 1982-84 from CACEX, unpublished data).

YEAR	OCT. PRICE Cr$	MAY PRICE Cr$	CHANGE (%)	INFLATION RATE (%)	REAL CHG. (%)
1973-74	1.75	3.45	97	15	82
1974-75	3.10	2.50	(-) 19	12	(-) 7
1975-76	2.40	3.20	33	30	3
1976-77	4.20	5.70	36	25	11
1977-78	5.65	7.45	32	21	11
1978-79	8.25	12.00	45	28	17
1979-80	16.75	19.75	18	56	(-) 38
1980-81	21.50	26.00	21	52	(-) 31
1981-82	36.50	92.50	153	44	109
1982-83	132.00	150.00	13	104	(-) 91
1983-84	310.00	1050.00	239	91	148
Average			49	34	19

harvest, which would feed them until babassu fruit began to fall again in August and September.

Since babassu kernel extraction is closely meshed with the overall peasant economy, a short-term reallocation of labor in response to price surges is not to be expected. Some analysts have suggested that there has been a progressive deterioration in the terms of trade between babassu kernels and goods that peasants obtain in exchange for them. Such

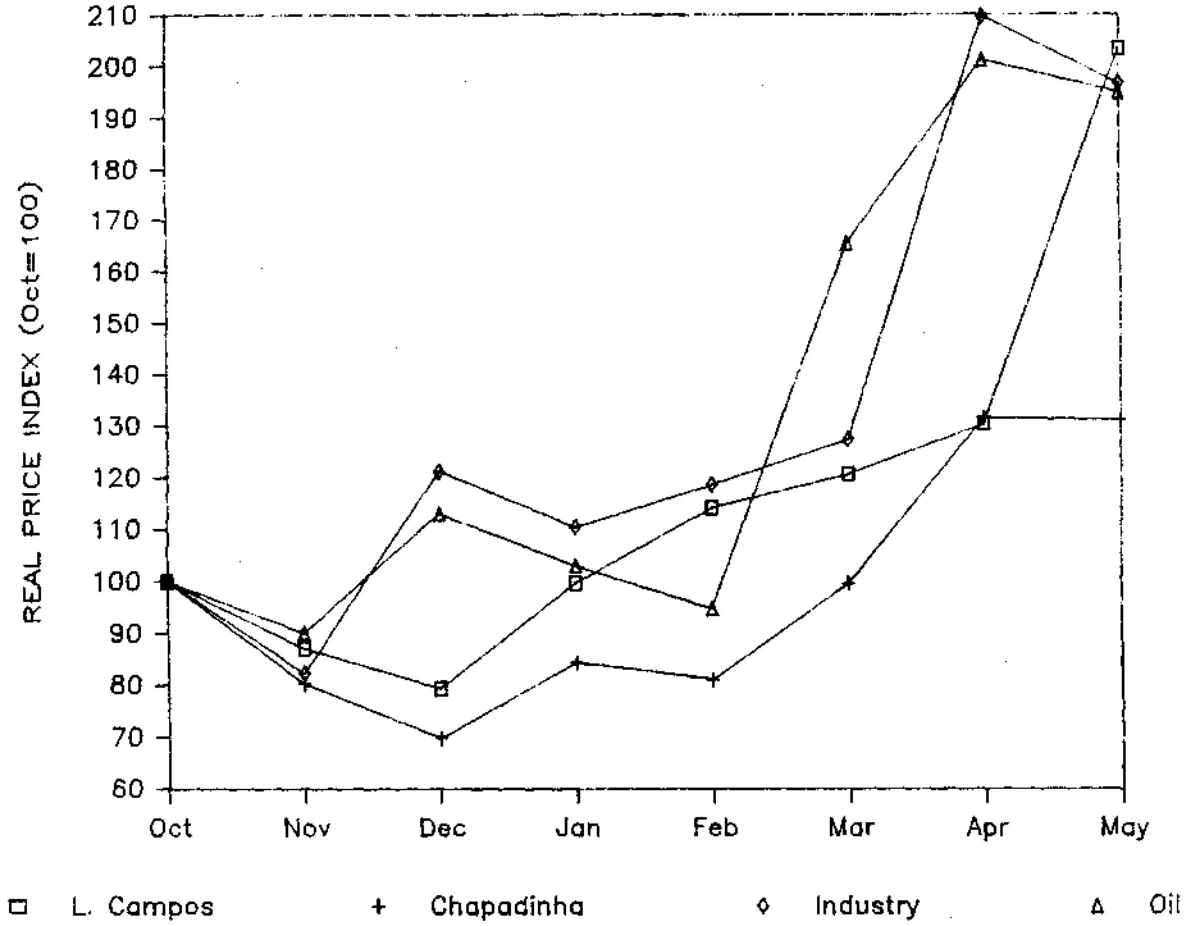

Figure 7.10. Real price indices - Lima Campos and Chapadinha producer prices; industry kernel purchase price, São Luís; domestic oil price: Oct. 1983 - May 1984.

deterioration, they suggest, might have motivated more permanent shifts in peasant production strategies.

For example, Kono (in PIPES, 1982) blames the apparent stabilization in kernel supplies since 1980 on a decline in the kernel-to-rice price ratio. This theory suggests that former kernel producers had been induced to allocate labor to other activities than babassu extraction by the relative price shift. To check this hypothesis, I compared the price ratio between rice and babassu kernels in 1973 and 1983 in Maranhão. There had indeed been some erosion in the relative prices of the two commodities: whereas one kg. of babassu kernel was able to purchase 3.8 kg. of rice in 1973, babassu kernel buying power fell to 2.3 kg. of rice in 1983, declining 39 percent.

The findings of my research reported in Chapter V, suggest that babassu production intrinsically complements other sources of rural income by making use of otherwise idle household labor during the period between annual crop harvests, a period when few income generating alternatives exist. Relative price changes ultimately may effect alteration in the patterns through which rural households allocate labor. To bring about such a change, however, babassu prices would have to fall below what must be an extremely low labor opportunity cost before such a relative shift would bring about a substantial reduction in kernel extraction. Greater credence should be given to changes in land use and in peasant access to resources as sources of supply stagnation if the feared kernel output stabilization proves to be more than a short-term phenomenon.

Another possibility that emerges through analysis of relative price statistics is that babassu oil extractors have deliberately maintained kernel prices low since the onset of national economic crisis in 1979. This tactic would tend to suppress kernel supply, but maintain production margins sufficiently high that those firms able to secure diminished supplies would reap the rewards. To test this alternative hypothesis, I have analyzed real prices for kernel, oil, and press cake from 1973 to 1984 (Figure 7.11). While there were some fluctuations in years such as 1974, when the export market opened, the real kernel price expressed in constant 1975 US dollars remained fairly stable at an average of $0.34 throughout the seven-year period from 1973 to 1979. During the same period, industrialists were able to obtain gross product margins over kernel cost that averaged 22.6 percent, but ranged from a high of 41 percent in 1973 to a low of seven percent in 1978.[22]

In contrast, the period 1981 to 1984 shows a different picture. While industrialists were able to boost their gross margins to a stable 40 to 42 percent during this period, kernel prices in real terms declined to an average of only

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[22] Gross margins were calculated on kernel-equivalent product value for oil and press cake using conversion rates of 53 percent for oil and 35 percent for press cake, as reported by industrialists in my survey. If conversion rates were actually higher than these averages due to improvements in industrial technology, these firms would have higher margins.

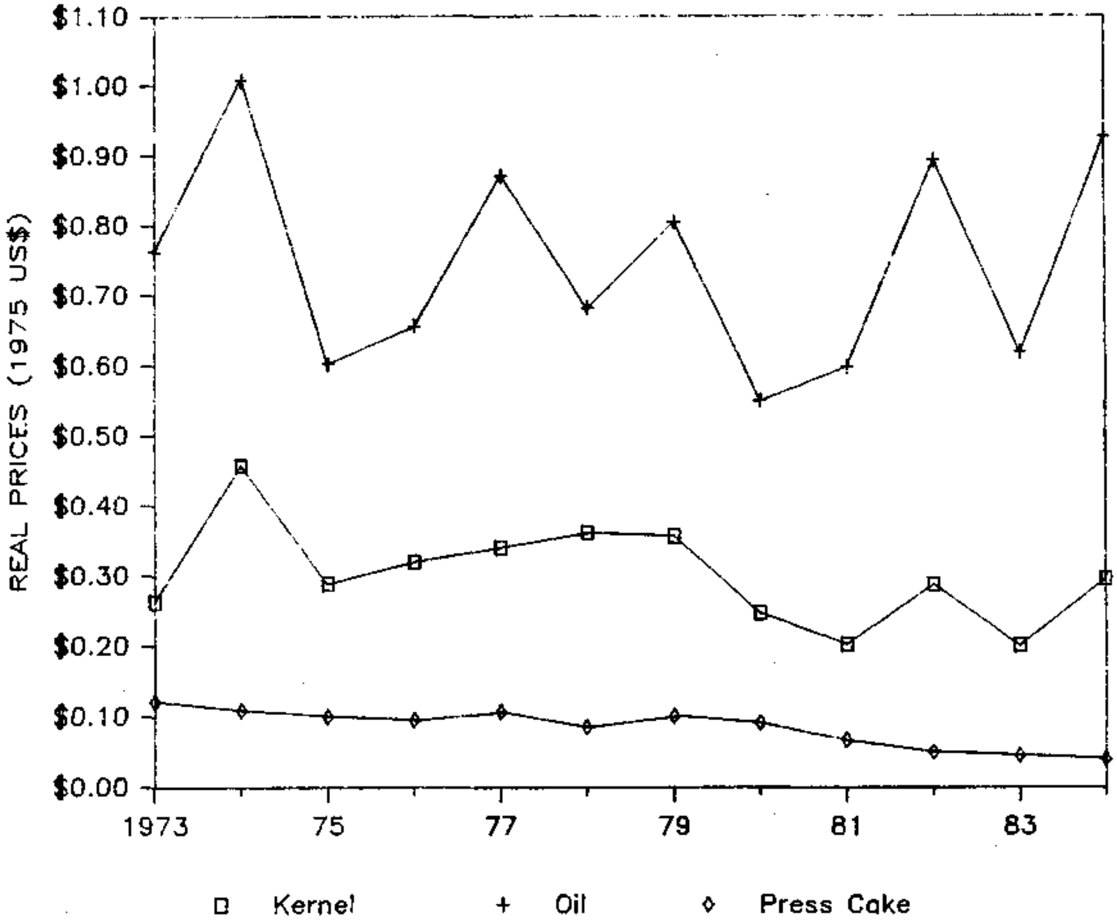

Figure 7.11. Real kernel, oil, and press cake prices in 1975 constant US dollars per kg.: 1973-1984 (CACEX data - see Table 7.7. for sources).

$0.25 per kg., a drop of 27 percent from the previous period's average. This decline was not gradual. Rather a sharp decline in real kernel price took place from 1979 to 1980, and prices remained low throughout the ensuing five years.

These data suggest that the babassu industry possesses some measure of oligopsony power in its raw material markets, a possibility that makes their complaints regarding competition for scarce supplies lose credibility. In fact, industrialists asserted that it is they who set raw material prices, with regard to the price current for products in their final markets.

On the other hand, it is unlikely that oil extractors are able to behave as oligopolists in their final product markets. Despite some degree of protection exercised through tariff barriers against foreign imports of lauric oilseeds, the babassu industry has been vulnerable to erosion in domestic markets.

Since raw material costs represent by far the largest component of operating costs, the industry's ability to lag price increases or maintain high gross margins using oligopsony tactics furnish the most obvious opportunities to weather the economic crisis. In the long-run, however, such tactics, unless accompanied by a real increase in final product value, will erode raw material supply and give landowners a justification to either eradicate babassu palms or remove peasants' access rights. The future of the industry seems in the end to depend to a considerable degree upon the conditions and trends in final product markets, which determine the share of the pie that is to be distributed among the links in the babassu kernel chain.

Final Product Market Conditions and Trends

Although babassu kernel oil is only an extremely minor contributor to international trade, it was one of the major edible and industrial oils in Brazil until being rapidly dwarfed, as were all other oilseeds, by expansion of soybeans in the 1970s. From 1957 to 1966, babassu oil fluctuated between 10 percent and 16 percent of total Brazilian fats and oils production. Over the same period, output of babassu oil more than doubled (Braga and Dias, 1969). In fact, babassu kernel is still the largest source of lauric acid oils in Brazil (Table 7.8). Copra production has never been significant, and most other domestic lauric oils are derived from other native palms having neither babassu's broad geographical coverage nor its rate of extraction by local inhabitants. In recent years, plantations of dende (African palm) have begun to furnish palm kernels to lauric oil extractors to complement babassu and other native palm kernel as raw materials, but it will be some years before increased plantings of dende will result in kernel supplies sufficient to compete with those from babassu.

Babassu Oil Markets

There are two principal markets for babassu kernel oil: industrial and edible oil markets. In industrial applications today, babassu oil is mostly used in the fabrication of extruded soap (composed of 15 to 30 percent babassu oil) and "coco" soap (35 to 65 percent babassu oil). As babassu oil prices have increased relative to other intermediate materials, there has been a movement away from coco soap toward extruded soap in the output composition of the cleaning industry, and a parallel movement toward detergents made from synthetic compounds rather than natural oils. Nevertheless, the soaps and cosmetics industries have constituted a growing market for babassu oil relative to other uses. In estimates of internal oils consumption, 42.5 percent of babassu oil produced was used in soap manufacture in 1968 (Braga & Dias, 1969), increasing to 62 percent in 1974, and perhaps 78 percent in 1978 (FTI, 1982). The remainder was used for edible purposes, such as in cooking oil, margarine, and shortening.

The utilization of babassu oil for edible purposes has suffered a continuing decline, as the lower-priced soybean oils have replaced babassu kernel oil in southern markets. Medical discoveries regarding the dangers of high-cholesterol diets and marketing campaigns during the 1950s and 1960s whetted consumers' appetites for polyunsaturated oils. In consequence, shortening and margarine made of babassu kernel, which produces a heavily saturated oil, have paled in signi-

Table 7.8. Production and consumption of babassu, palm kernel and coconut oil in Brazil: 1977 - 1982 (Gessey-Lever, unpublished data).

('000 tons)

TYPE OF OIL	1977	1978	1979	1980	1981	1982
Babassu Kernel Oil						
Local Production	109.6	94.0	115.0	83.7	68.0	60.0
Exports	4.4	9.2	20.4	2.6	0.6	0.0
Consumption	105.1	84.8	94.6	81.1	67.4	60.0
Palm Kernel Oil						
Local Production	3.2	4.1	4.2	4.5	4.7	2.7
Imports	1.0	---	---	---	---	---
Consumption	4.2	4.1	4.2	4.5	4.7	2.7
Coconut Oil						
Local Production	0.9	0.9	0.9	0.9	0.8	1.0
Imports	---	---	---	---	1.0	1.7
Consumption	1.0	0.9	0.9	0.9	1.8	2.7
Total Lauric Oil Consumption	110.4	89.8	99.6	86.4	73.9	65.4
Percent Babassu	95.3	94.4	94.9	93.9	91.2	91.7

ficance on the domestic edible oils scene, particularly in the industrialized south. In the Northeast, consumers continue to prefer babassu oil, but the overall share of vegetable oils in household consumption in the Northeast is substantially lower than that in the rest of the country.

Per-capita consumption of vegetable oils increased relative to lard and other animal sources in Brazil as a whole between the 1960s and mid-1970s, according to household dietary surveys carried out at the time (Getúlio Vargas Foundation, 1970; IBGE, 1977). In the Northeast, babassu shortening was responsible for a good share of this increase, while elsewhere in Brazil consumption of edible babassu oils declined as a proportion of total sources of oil, while "other oils," especially soybean oil, increased dramatically (Table 7.9). Edible oils consumption in all regions of Brazil is strongly income-elastic (Figure 7.12). While the Northeast experienced real per-capita growth in gross regional product of nearly 100 percent from 1972 to 1981 (SUDENE, 1984), real improvement in personal income was restricted to a small portion of the region's population. Hence, the prospects appear slim for future augmentation in domestic demand for edible babassu oil products within markets limited primarily to the Northeast.

An estimate of the composition of Brazilian internal market demand for both edible and industrial uses of babassu oil in 1980 is provided in Table 7.10. The total domestic demand of 83,000 tons of oil presented in the table represents approximately 157,000 tons of kernel at current average extraction rates of 53 percent. Since the kernel marketing figures for 1980 were on the order of 220,000 metric tons, and there were minimal exports in that year, either the oil consumption level is conservative or kernel statistics are inflated. From industry interviews and an extrapolation of historical oil production data, it appears more probable that

Table 7.9. Average per capita consumption of fats and oils in Brazil, by major regions: 1960s and 1974-75 (Getúlio Vargas Foundation, 1970; IBGE, 1977).

FAT/OIL	Kg. Per Capita Per Year: 1960s BRAZIL	1960s NORTH-EAST	1960s EAST	1960s SOUTH	1974/75 BRAZIL	1974/75 NORTH-EAST	1974/75 EAST	1974/75 SOUTH
Margarine	0.2	0.05	0.2	0.5	0.7	0.3	0.8	1.1
Vegetable Oils	3.2	2.1	1.7	5.6	3.3	1.9	3.5	4.4
Soybean Oil	n.a.	n.a.	n.a.	n.a.	n.a.	1.2	0.7	0.4
Other Veg.	n.a.	n.a.	n.a.	n.a.	n.a.	0.7	2.8	4.0
Babassu/Coco Oils	0.3	0.2	0.6	0.1	0.8	2.0	0.4	0.1
All Vegetable Oils	3.7	2.3	2.5	6.2	4.7	4.2	4.7	5.6
Lard	4.6	1.4	4.6	7.4	5.0	0.4	7.6	7.0
Butter	1.2	1.1	1.2	1.2	0.4	0.4	0.3	0.4
Bacon (and ham)	3.9	1.6	7.1	2.8	1.5	1.3	2.3	0.9
All Animal Fats	9.8	4.1	12.9	11.4	6.7	2.1	10.2	8.3
Total Oils & Fats	13.5	6.4	15.4	17.6	11.4	6.3	14.9	13.9

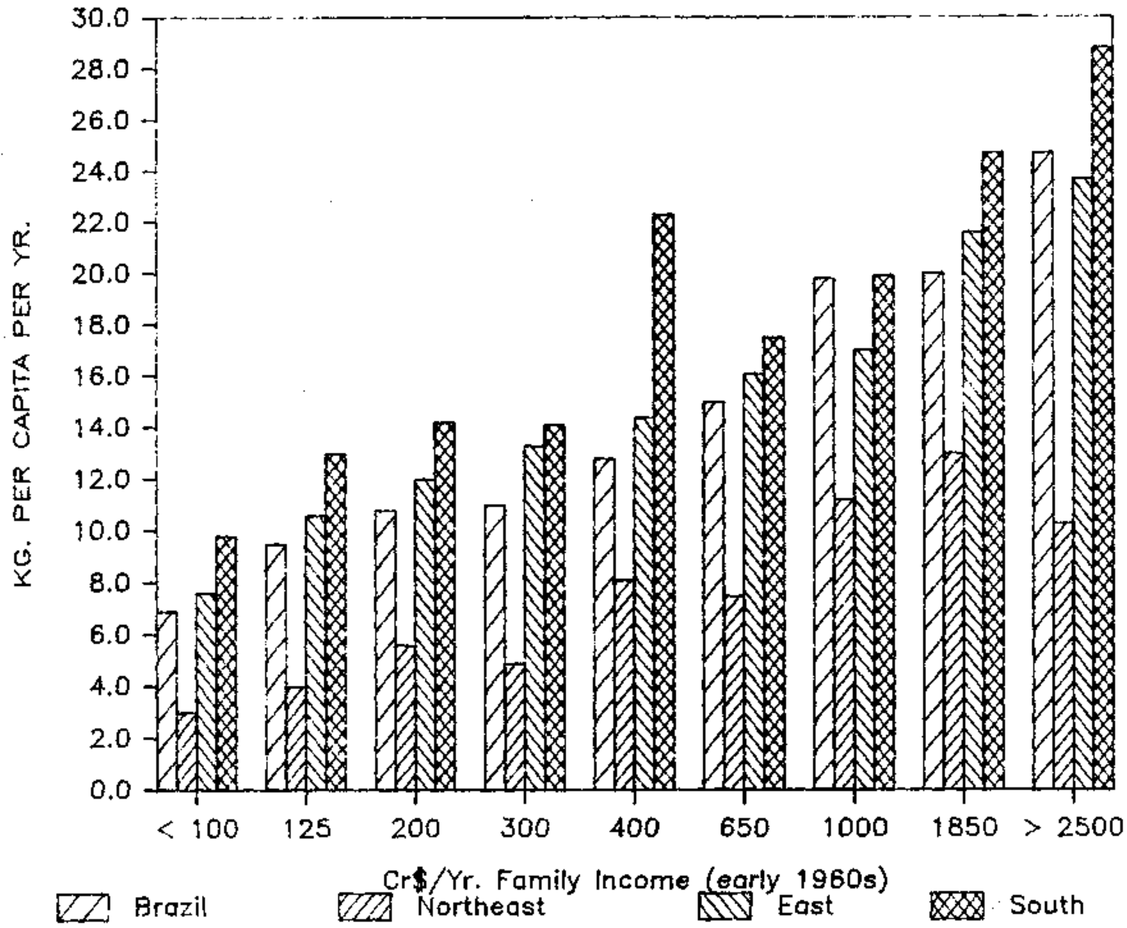

Figure 7.12. Income elasticity of edible fats and oils, Brazil and major regions: 1960s (Getúlio Vargas Foundation, 1970).

Table 7.10. Estimated domestic demand for industrial babassu oil by final product, 1980 (FTI, 1982:4-45).

PRODUCT	ANNUAL CONSUMPTION OF BABASSU OIL	
	tons	%
Extruded soap	40,000	48
Coco soap	25,000	30
Edible purposes	18,000	22
Total demand	83,000	100

the latter is the case. The concern that kernel output has stabilized or declined since 1979 is supported by this finding, but it appears more likely that compression in final market demand rather than perverse raw material supply response is the source of the decline.

The above analysis indicates that the trend in the composition of this market is one of stabilization or reduction in edible oil demand. On the one hand, industrial uses such as use of babassu oil for soap production will increase with recovery from the economic crisis. However, there may be a continuing trend toward use of heavy-duty synthetic (HDS) detergents in the overall composition of the cleaning product market.[23]

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[23] Based on data gathered by FTI (1982), the participation of HDS detergents in the overall Brazilian cleaning products market has increased from two percent in 1960 to 45

Even without the HDS revolution in the cleaning products industry, babassu oil prices have been too high to justify high proportionate rates of use in soap manufacture. Instead, tallow is used in greater proportion. Currently, tallow constitutes about 70 percent of the oil composition of extruded soaps, which represent a larger market share than the higher quality "coco" hand soaps.

Other industrial applications of lauric oils such as toiletries, fatty acids, alkyd resins, and other specialized areas are minor in proportion to total demand, and are not currently growth industries. While there has been some excitement regarding the prospect of using babassu oil as a substitute for diesel fuel, it appears that such nontraditional markets will not be readily penetrable.[24]

International market demand for babassu oil is closely linked with the availability of copra and palm kernel oils. Babassu oil has characteristically entered world markets only when trade with coconut and African oil palm growers was cut off in times of war, or when drought or pests reduced avail-

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percent in 1980. There may be some tendency for this rate of substitution to stabilize unless petroleum prices fall relative to lauric oil and tallow.

[24] Babassu oil apparently has very similar physical characteristics to diesel oil. Brazil's fuel substitution program has recently begun to look into the potential for substituting domestically-produced vegetable oils for diesel, to reduce still further the nation's dependence on imported petroleum. However, babassu's low productivity per unit land and undomesticated status have tended to dim the initial enthusiasm for this tactic. If any vegetable oils are to be diverted for fuel use, they will be cheaper oils obtained from domesticated sources having high productivity per unit land, such as soybeans and African oil palm.

Table 7.11. Correspondence between babassu oil exports and copra shortages in world markets (FAS, 1985 and prior years).

	Exports	
YEAR	BABASSU OIL ('000 tons)	WORLD COCONUT OIL ('000 tons)
1972	2.0	1,679
1973	1.4	1,489
1974	40.3	947
1975	0.9	1,668
1976	0.4	2,007
1977	4.4	1,612
1978	9.2	1,679
1979	20.4	1,462
1980	2.6	1,518
1981	0.6	1,623
1982	0	1,732
1983	9.5	1,083
1984	10.0	1,266

able supplies of substitute lauric oils sources. Such shortages occurred most recently in 1974-75, 1979-80 and 1983-84, apparently following a four or five-year cycle (Table 7.11). In 1983, after several years of negligible world trade, babassu oil once again entered international markets due to a serious drought afflicting both the Philippines and Malaysia and to a pest problem in Malaysian palm production. Babassu oil prices in international markets leapt from a seven-year low of US$ 520 to over US$ 900 per ton FOB in less than six months. Figure 7.13 shows how babassu oil prices during 1973-84 followed international coconut oil prices. The extracting industry in the babassu zone diverted some of its product to these markets, since they could avoid shipping to São Paulo or Rio de Janeiro with attendant transport, interest, and other costs. A national policy emphasis on exports to pay the expanding external debt, by providing export financing and exemption from value-added taxes, also motivates industrialists to export babassu oil.

Concurrently with the coconut oil price spiral, a number of factors, particularly low U.S. output, doubled prices in international soybean oil and meal markets. Brazil's particularly good soybean harvest stimulated oil exports, but led to a domestic oil shortage and price increases. This, in combination with the renewed international interest in babassu oil, resulted in dramatically higher internal prices for babassu oil as well.[25]

Although the federal export commission CACEX issued a request for babassu processors to do something about the situation in response to complaints from domestic oil buyers, the government's signals were mixed. On the one hand, CACEX financed exporters and exempted them from value-added taxes; on the other, they weakly slapped the exporters' wrists for not retaining sufficient volume of the product to satisfy

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[25] José Carlos Bast, Economist, Brazilian Association of Vegetable Oil Industries, personal communication.

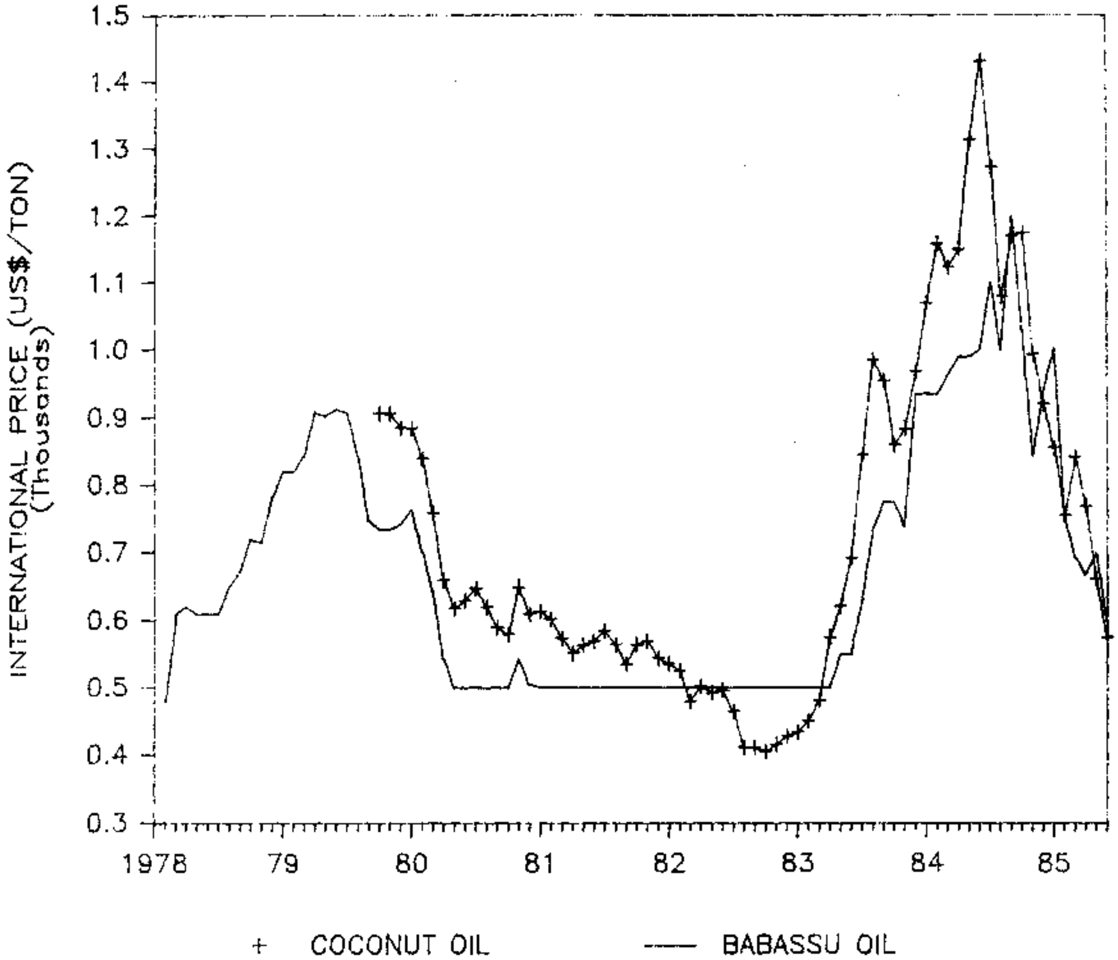

Figure 7.13. Comparison of monthly coconut oil and babassu oil prices in international markets: 1977 - 1985. Coconut oil is CIF Rotterdam (FAS, 1985 and previous editions); babassu oil is FOB São Luís.

domestic demand and avert inflation. The response of the oil extractors was to complain that their raw material supplies could not be expanded to serve both markets. The only solution that emerged was that of embarking on an educational campaign to convince landowners to stop cutting babassu palms.

In the short-term, this situation bodes well for oil producers who can recoup what they lost in volume by taking advantage of the export price premium and its effects on domestic prices. However, the ability of the domestic soaps and cosmetics industries to pass on these price increases to its consumers is questionable. Some of these final consumption goods have been placed under periodic price control by the government. Once the international copra and palm kernel markets returned to normal in late 1984 as rains returned to Southeast Asia and new palms entering maturity there added to total output, the demand for babassu oil has returned to its secular low level in international markets. By May of 1985, babassu oil export prices were back down to US$ 700 per ton FOB, and there were no exports during several months in 1985 (unpublished CACEX data).[26]

If internal prices do not also subside and national stagflation continues, there would be reason to fear domestic babassu oil markets will become even more restricted. Industrial oil buyers are understandably fed up with babassu oil's seasonality of supply and year-to-year fluctuations in

[26] I am grateful to Wilson Milfont, Jr. for transmitting these recent oil export price figures from Brazil.

availability and price responding to international market conditions. They have successfully overcome trade restrictions to import small quantities of coconut oil when domestic sources dried up. However, both 1984 and 1985 have been years of unexpected growth for the Brazilian economy.[27] If current economic conditions persist, it is possible that the babassu oil industry will be buoyed up by the rising tide of prosperity as well as by concern for the continuing interregional disparities between Northeast and southern Brazil.

Press Cake and Feedmeal Markets

Babassu press cake, containing roughly 23 percent protein, is used primarily as a constituent of animal feedmeals. In contrast with babassu oil, press cake and meal by-product markets have been predominantly international for some time, with Germany and the Low Countries being the major buyers. The use of animal ration is still uncommon in Brazil, particularly in the Northeast. After 1960, when the babassu oil extraction industry moved to the Northeast, a larger share of these by-products began to be exported than used internally, owing to high transport costs to internal markets and growth in the soybean industry in the south.

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[27] In mid-1984, the Brazilian economy began an astonishing turn-around that ended several years of negative GDP growth. The nation reached an annual GDP growth rate of 4.5 percent in 1984, and most projections anticipate a seven percent growth rate in 1985.

Prices in domestic markets for both press cake and meal have also been lower than international prices.

Seasonal demand for feed ration on ranches in the Northeast faced with poor pasture conditions due to a major drought in combination with declining real prices in international markets (Figure 7.11) have, however, stimulated retention of babassu oil by-product meals in Brazil since 1979. Table 7.12. shows the geographic distribution of babassu kernel oil and by-products marketed in 1980. Meal and cake exports dropped precipitously during the drought (Figure 7.14).

Table 7.12. Destination of babassu oil and by-products: August to October, 1980 (Salete, 1982).

(percent)

DESTINATION	INDUSTRIAL OIL	REFINED OIL	MEAL & CAKE
Northeast Brazil	31.6	62.3	42.9
São Paulo	35.4	24.4	--
Other Brazilian states	24.7	13.3	--
Foreign markets	8.3	--	57.1
Total	100.0	100.0	100.0

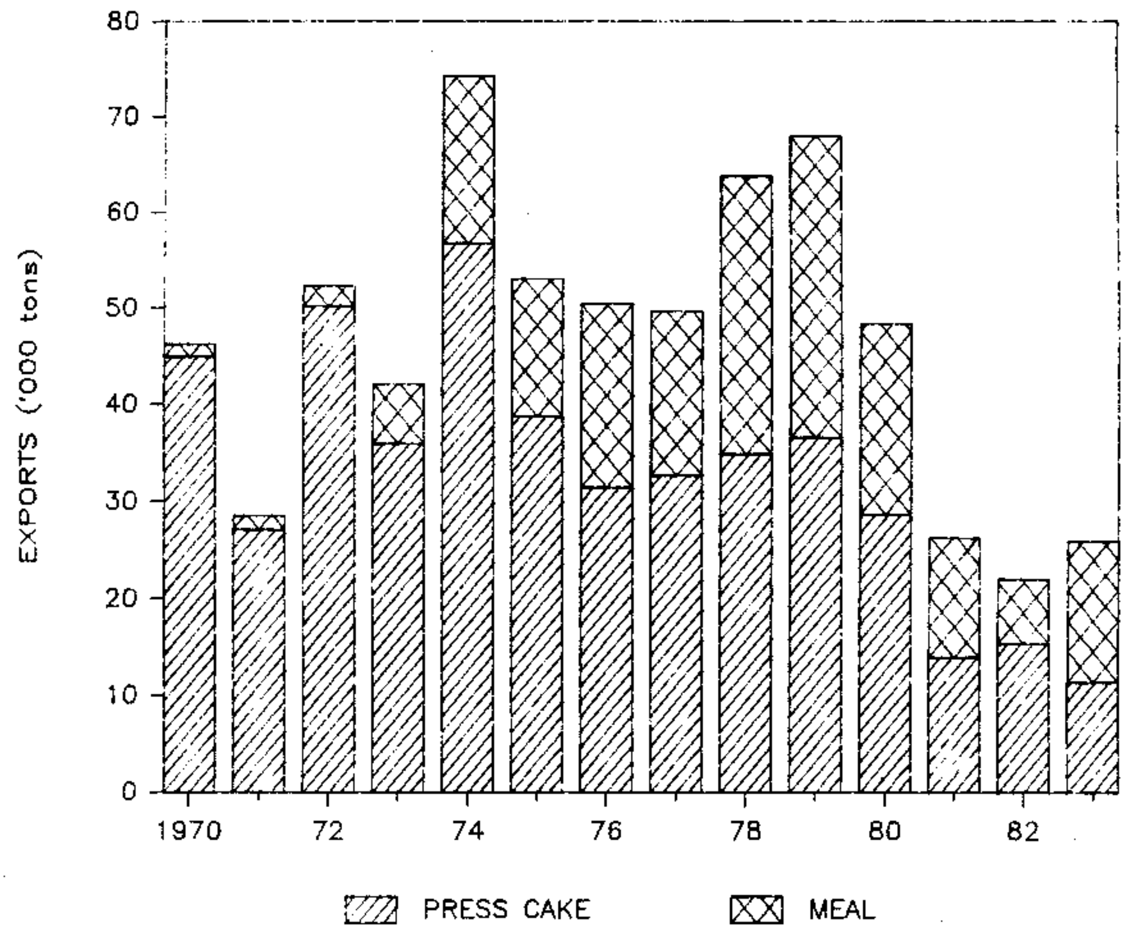

Figure 7.14. Babassu kernel press cake and meal exports: 1970 - 1983 (CACEX data, 1970-1980 from FTI, 1982; 1981 - 83 extrapolated from Maranhão figures).

As by-products, press cake and meal output will grow or decline proportionately with oil production. The relative importance of meal to cake has increased with the shift towardsolvent extraction (Figure 7.14). This has been a profitable strategy, as meal prices are only slightly less than those of cake, yet the removal of the additional oil adds significantly to gross revenues. On a unit volume basis, oil is much more valuable than press cake and meal, with an historical price ratio of nine to one. Nevertheless, the sale of kernel extraction by-products represents a crucial profit center. The industry covers some of its operating costs and often reaps a considerable share of its profits from sales of press cake or meal. The stability of their markets bodes well for the industry even if the oils picture looks bleak.

Summary and Outlook

The babassu oil industry evolved through three distinct phases, each of which corresponded with an intensification in the rate of kernel extraction by rural inhabitants. The first phase, during which most babassu kernels were exported, was followed by a second, import-substituting industrialization period, during which most babassu oil was extracted in southern Brazil. The final phase represents that during which the industry established its base in the babassu zone itself. Rather than exporting kernels either overseas or to the south, the oil extraction industry now not only produces oil and press cake or meal for export, but some firms are involved in producing final products such as refined oil, soaps, and glycerine.

Benefiting from surplus capital in the national economy during the 1970s, babassu oil firms have expanded capacity and modernized production technology. While growth in capacity was matched by increased buying power for raw materials and parallel growth in product markets, the industry has continued to operate at a high level of idle capacity. At present, the installed oil extraction plant would be capable of processing more than the entire regional kernel output, of which only about one-third is actually extracted by peasant producers.

Idle capacity is explained by both the easy flow of investment capital and the seasonality of the babassu harvest. Industrialists have increased plant scale to be able to process as much kernel as possible in the fairly short time period when kernels are being extracted. This allows them to generate working capital to enhance their purchasing power. While industrialists complain of rampant competition for raw materials, such competition may actually be due to excessive plant expansion rather than real shortages of raw material in relation to demand for final products.

Peasant producers supply babassu kernels through a maze of intermediaries. Although peasants' bargaining power for kernel trade appears to have improved over time, a considerable share of kernel value, accounting for nearly 40 percent of the industry's purchase price, is distributed among landowners and merchants. The latter can make higher-than-average profits when market conditions are propitious by lagging price increases to producers. Furthermore, available data indicate that the industry's average margin of earnings on kernel processing may have increased somewhat during the national economic crisis since 1980, through a reduction in the proportion of product sales value going to raw material costs. Such oligopsony tactics are incongruent with industrialists' complaints of raw material supply competition, which can be discounted as a source of current industry woes.

Despite what may be increased profits on oil extracted, industrialists are facing reduced demand for their principal product in its final markets. Some of the industry's present contraction may be a short-term situation, to be reversed with the nation's return to high GDP growth in 1984 and 1985. However, the prospects for substantial future growth of babassu's share in the domestic soaps and cosmetics final product markets appear fairly bleak. Market demand does not promise to reinvigorate procurement of babassu kernel in the future except during rare export market openings for babassu oil, such as occurred in late 1983 through 1984.

The impact of these conditions on landowners' decisions is to motivate changes in land use toward products having more secure markets. The lack of working capital and persistent plant closings have reduced rural demand for kernels. Although the babassu oil industry on its traditional footing possesses its own internal dynamic, it is apparent that the tendency is toward gradual diminishment in market share and regional economic importance. Nevertheless, a series of recent developments in the babassu zone is presented as offering prospects of reinvigorating both the industry and the regional economy. The case for and against the innovative technology for processing of whole babassu fruit is presented in the next chapter.

CHAPTER VIII

TECHNICAL INNOVATION IN BABASSU FRUIT PROCESSING

"Se aproveite tudo do babaçu, até a amêndoa."

"Everything from babassu is useful, even the kernel." (Popular proverb in Maranhão)

Despite serving as an important contributor to household incomes of an estimated 420,000 peasant families throughout Brazil (Mattar, 1979), the babassu palm industry still rests on extractive cottage production and a predominantly obsolete and under-utilized oil extraction plant. Both the agricultural economy and the processing industry are in crisis, the former due to intensification of production systems incompatible with extractivism and subsistence food production, and the latter due to contractions in demand for babassu oil and in working capital arising from the general crisis in the Brazilian national economy. As we have seen in Chapter VII, the tendency of the babassu industry is toward a reduction in market share and a decline in relative regional importance.

The rudimentarity of the kernel extraction process employed by the peasantry has historically been blamed for limiting babassu oil's competitive footing in international trade. Conceivably, a device that could extract babassu kernels mechanically would result in a reduction in raw material cost, thus enhancing final product marketability. Other by-products besides the press cake or meal could be obtained, thus adding to the industry's financial security. There has been no lack of efforts to develop mechanical cracking equipment since the early 1920s, when babassu kernel first entered world markets on a regular basis. To date, no such effort has been fully successful, whether for technical, administrative, or financial reasons.

As a result of renewed efforts by industrial engineers and venture capitalists during the 1970s, the fundamental technological bottleneck to whole babassu fruit processing has been overcome, in the opinion of knowledgeable experts. With little additional research and development, this technology can be established at the core of financially-sound enterprises involving by-product processing for a range of potentially attractive domestic and international markets over the short term (Pick et al., 1985).

The prognosis is not so positive for the peasantry engaged in babassu extraction, however. A major shift in babassu processing technology is expected to result in significant alteration in labor conditions and production relations in the region. The purpose of this chapter is to investigate the validity of the claims that serve as the ideological underpinning for industrial innovation in the babassu industry.

A History of Babassu Fruit Processing Ventures

"<u>As máquinas para quebrar coco são máquinas para coco quebrar</u>"

"Coco breaking machines are machines for cocos to break"

R. Teixeira Leite (1953:21)

The concept of mechanical babassu cracking has been traced as far back as 1853, but it was not until the early 1920s that babassu fruit processing machines began to appear on the scene (Markley, 1963). Technology devised to extract kernels mechanically from babassu fruit focused initially on methods imitating the manual process used by the peasantry. Devices were tested which would pneumatically pulverize the fruit or crush them through rollers, cut or chisel them into sections, or saw them in quarters. In many cases, the equipment involved manual feeding of the fruit and separation of the kernels from the husks.

Between 1918 and 1954, seven firms were documented to have established enterprises for industrializing babassu kernel extraction (Markley, 1963). Only one of these was a Brazilian company; the others involved European and American investors. Reportedly, none of the firms remained in operation for more than two years. Their failures were blamed on a combination of inadequate knowledge of the peculiarities of the raw material and the local environment, technical limitations of the equipment itself, or lack of financial viability due to excessive costs of fabrication and operation when compared with the final product value.

Factors Limiting Mechanical Kernel Extraction

The most important factors limiting the success of mechanical kernel extraction are those of variable fruit size and shape, number of kernels, and positioning of kernels within the fruit wall or endocarp. As described in Chapter V, babassu fruits are composed of four layers, each component differing in hardness, form, and chemical composition from the others. Assuming that each fruit were similar in size and shape, a factor controllable by grading devices, it is still necessary to break through three layers to expose the oil kernel. Tests on 45 babassu fruit gathered from seven areas by Teixeira Leite (1953) revealed that babassu fruit require an average longitudinal force of 5.4 tons (s.d. = 1.5) to break, making babassu the most resistant among the neotropical fruit-bearing palms. The only species approaching it is the ivory nut palm, whose fruit requires slightly over one ton of force to break (Kiltie, 1982; cited in Anderson, 1983).

The proportional composition of each layer differs somewhat among fruit from different palms within the babassu complex. Once these variably-sized barriers are breached, moreover, the kernels must be extracted more or less whole to avoid oxidation and rancidity.[1] But there may be anywhere

[1] This proviso holds true for operations that planned to sell kernels alone to a domestic or foreign market. By the 1960s it became increasingly likely that a fruit cracking operation would incorporate oil extraction, or would sell kernels to a regional crushing plant in the babassu zone. Hence kernel fragments would be acceptable. Maquinas Piratininga, the major producer of babassu kernel oil expellers in Brazil, in its experiments with fruit breaking equipment,

from none to 11 kernels of different size and shape hidden in irregularly-shaped cavities in the woody endocarp (May & Anderson, unpublished data). The machine would somehow have to be flexible enough to allow for this added variability. Finally, because no machine can be expected to perform with such flexibility, some means would have to be found for separating bits of fruit husk from kernel fragments to reduce the impurity levels or for drying the fruit before breaking to reduce humidity that causes husks to stick to kernels.

Seasonality of fruit harvest confers added problems. Since most babassu fruit does not mature year-round, the industry would have to stockpile large volumes of raw material in order to function more than six months out of the year. But here the kernel consuming larva or gongo mentioned in Chapter V returns to the scene. Larval depredation of kernels is not a severe problem for gatherers who collect and break fruit shortly after they fall. Gatherers are also not above snacking on the gongo when it appears. However, fruit that is stored for any lengthy period is far more likely to be predated, with subsequent severe losses in kernel output. Only by fumigating the fruit before storage is there some chance that developing larvae will be suppressed.

Finally, the sheer weight of the fruit necessary to extract any significant marketable volume of kernels leads to substantial transportation costs. In a region where paved

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found that kernel fragments, if heated sufficiently after extraction, would remain usable for some time.

road construction on any scale did not commence until the late 1960s and where river and rail transport was slow and risky, basic infrastructure appeared for many years the principal impediment to rationalized babassu exploitation. In most cases, however, the firms which attempted to mechanize kernel extracting established their factories deep in the interior of the palm forests, where the corroding ruins of their cracking machines can still be found.

The Rise of Whole Fruit Processing

It is a tribute to the qualities of the babassu palm, or to the Quixotic spirit of human inventiveness, that repeated failures in no sense curbed the fascination generated by the problem of fruit industrialization. Nearly 50 patents for babassu fruit-breaking machines had been registered in Brazil by the early 1950s (Teixeira Leite, 1953). At least that many have appeared on the scene in the intervening 30 years. Hundreds of pamphlets, newspaper reports, articles in foreign and domestic journals, technical studies, and books have been printed promising imminent resolution of the problem.[2]

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[2] The production of enthusiastic literature concerning babassu corresponds closely with export conditions and national economic preoccupations. The pre-World War II phase, when European and U.S. demand for oilseeds were booming, was a good production period for babassu literature. The early 1950s, an era of intensified import substituting industrialization efforts, also stimulated writing on babassu's potential and the need to improve regional infrastructure to develop the oil industry. The 1970s saw a dramatic boom in government involvement, during the period when native biomass resources were seen as the answer to Brazil's energy future.

Several eminent scholars and scientists, among them botanists, chemical engineers, and economists devoted much of their careers to its pursuit, while many more have abandoned it in frustration. What makes babassu so fascinating, and how can we account for the continuing failures of the people obsessed with making their fortunes and their country's future depend on this wild palm's "wonder nut"?

The answer appears to lie beyond the oil kernel, and therefore beyond the quest for a stable oil industry based on its extraction. Nature in her infinite wisdom and diversity had seen fit to clothe the fertile valleys of Maranhão in vestments of babassu palms. There had to be a way for those who inhabit the palm stands to derive some benefit from more of this prolific plant than the oil kernel, accounting for merely seven percent of the fruit by weight. Like the peasantry who learned from the original indigenous inhabitants every conceivable use for the palm, as described in Chapter V, it was not long before the goal of a mechanical kernel extractor was supplanted by the search for industrial technology that would make use of the entire fruit.

By the eve of the Great Depression, laboratory experiments by chemist Fróes de Abreu (1928) revealed that babassu fruit could potentially generate a wide variety of products considered strategic to Brazilian industry and commerce. A few of the fruit processing ventures attempted since that time aimed at dry distillation of husks after kernel extraction, to yield charcoal and aromatic tars.[3] By the 1940s, the technology incorporated separation of the starchy mesocarp from the fibrous epicarp and woody endocarp. Laboratory analysis had found that babassu mesocarp contains crude starch in sufficient proportion to justify efforts to separate and perhaps refine it industrially or to ferment it for ethanol. In addition, the dry distillation or pyrolysis of babassu husk, researched in depth by Teixeira Leite (1953) and Vivacqua (1959), offered the potential to obtain valuable acetates as by-products after neutralization of pyroligneous acid. Pyrolysis also generated methyl alcohol and combustible gases which could be recycled as fuels within the babassu industry itself, thus reducing processing costs. Figure 8.1 shows the range of alternative products obtainable from babassu fruit industrialization, with reference to their source in the fruit's composition and their hypothetical output per unit raw material, based on laboratory and pilot industrial studies.

Peeling-Separating-Breaking Technology

Although the range of potential by-products of fruit industrialization had expanded considerably, there had still been no notable success stories in applying these lessons to

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[3] Babassu charcoal reportedly has composition and caloric potential comparable to that of the best coking coals, most of which Brazil must import to fuel a steel industry for the most part dependent on domestic wood charcoal and imported coke for reduction. However, babassu husk charcoal suffers from small granimetry and fragility, which limit its coking potential unless briquetted (Teixeira Leite, 1953; FTI, 1982).

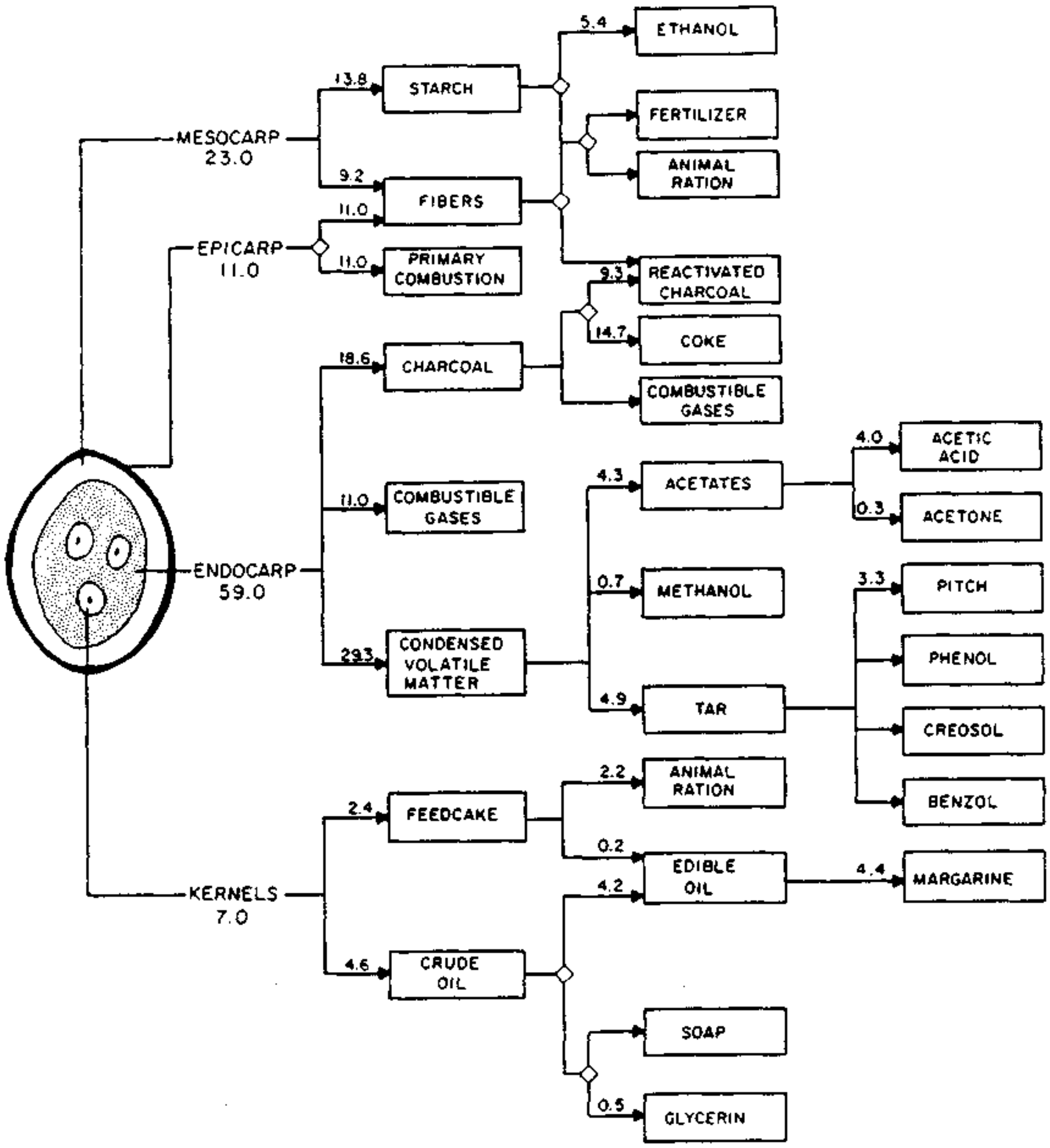

Figure 8.1. By-product alternatives in babassu fruit processing. Diamonds represent "either/or" options (Anderson & Anderson, 1983).

the babassu problem as Brazil entered the 1970s. Yet several lessons had been learned. Among these was that, instead of attempting to break, crack, or cut the fruit in imitation of the peasant's club and hatchet technique, it is far more efficient to first remove the outer two layers before breaking. This approach was first developed by Vivacqua (1959) and has now become the dominant technology adapted by industrialists attempting whole fruit processing.

The process of fruit decortication (peeling), separation of the mesocarp and epicarp, and endocarp breaking to extract kernels was incorporated with varying degrees of success within several ventures at babassu fruit industrialization during the 1970s. The technology (known as PSQ[4]) has been fabricated at a range of scales by industrial equipment manufacturers in Brazil. Some of the venture capitalists developed or adapted their own PSQ equipment with skills no more sophisticated than those of an experienced mechanic. Recent studies evaluating the technology suggest that the PSQ process is effective and with a few more years of industrial testing, it will be commercially viable (IPT, 1979; FTI, 1982; Pick et al., 1985).

The PSQ technology involves two principal process stages. First, whole fruit are fed into the decortication apparatus — in most applications consisting of a vertical or horizontal cylinder with a rapidly rotating bar fitted with

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[4] The acronym PSQ refers to the technology of "peeling" (pelagem), "separation" (separação) and "breaking" (quebra).

iron hammers chained at intervals. Knives are sometimes placed along the walls of this cylinder to aid in decortication. This device in effect flails the epicarp and mesocarp from the fruit. In some equipment, the mesocarp, being powdery, falls through a screen which encloses the whirling bar and hammers and is blown out; the fibrous epicarp is removed by vibration. In other cases, the three components are transported together to a separate screening device from which the epicarp and mesocarp are jointly blown toward a hammer mill. In the latter, the mesocarp is transformed into a fine powder to be separated by vacuum from the epicarp.

Meanwhile, the endocarp, enclosing the kernels, is transported to a centrifugal breaking apparatus, sometimes after kiln-drying to ensure the minimum of husk adhesion to the kernels. The centrifuge typically consists of a cone-shaped helical core which rotates, drawing the hard endocarp downward into contact with knobs fixed to the inside walls of the device. The combination of force with which the endocarp is thrown against the outer shell of the centrifuge, friction from other nuts, and pounding against the fixed knobs breaks the endocarp. Unfortunately, the grinding impact also breaks most of the kernels as well. Large pieces of endocarp are recycled through the centrifuge to shake free smaller kernel particles, and the whole is transported to a bath of water with clay in which the two components are separated according to their specific gravities: the kernel floats and the endocarp sinks to the bottom. Figure 8.2 illustrates the

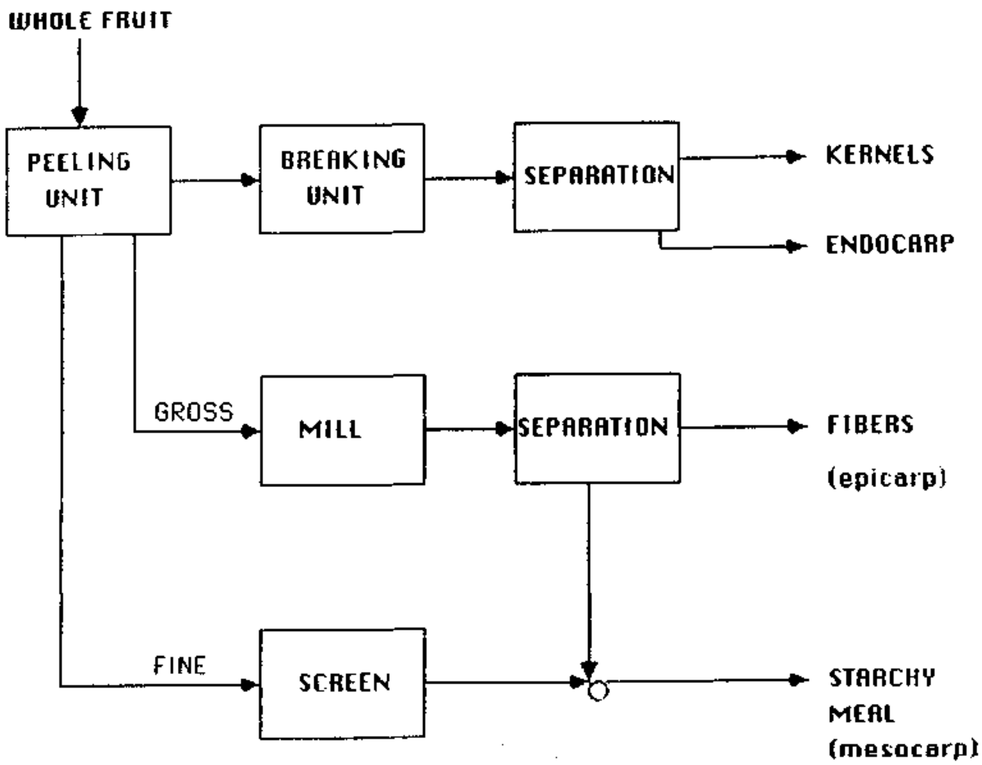

Figure 8.2. Schematic diagram of PSQ technology materials flow (translated from Mendes & Carioca, 1981).

materials flow used in process technology available in 1980 for PSQ in Brazil.

Now that all four parts have been separated, a decision has to be made regarding what is to be done with them. While there are hypothetically a multitude of potential products that might be derived from the components of babassu fruit, in practice only a limited number of these have been considered with any real seriousness in devising a product mix for enterprise investment. As with any business oriented toward profit maximization and some degree of portfolio diversity to cushion risk, the recent undertakings aimed at babassu fruit processing have limited themselves to several products which promised immediate market potential. As we will see, these primarily included charcoal, tar, oil, and feedmeal from press cake and mesocarp. In some of the more grandiose (and least successful) cases, investors also considered production of ethanol fermented from mesocarp starch, and acetic acid distilled from volatile matter obtained through pyrolisis of the endocarp. More exotic and fully-finished products must await the next generation of technical innovation, banking on the returns obtained in the first phase of technology adaptation and market building.

Dynamics and Actors in Technical Innovation

The entrepreneurs who engaged in testing and adapting PSQ technology for installation in the babassu zone differed from the owners and managers of the traditional babassu oil industry in several important respects. First of all, most were not natives of the babassu zone. Neither did they have a strong vested interest in the survival of the regional vegetable oil industry. Much of the capital invested in whole fruit processing ventures did not originate either in the babassu zone or the soaps and cosmetics sector. It was, however, predominantly from Brazilian sources.[5] After the

[5] The one exception was the small share in the CIT enterprise taken by a Portuguese multinational agribusiness firm, later withdrawn when the venture did not appear to be performing as promised.

multiple failures in industrializing babassu fruit processing during the previous half-century, little interest was generated among foreign investors to embark on new ventures.

Despite the riskiness of yet another campaign to resolve the babassu problem, venture capital was forthcoming in response to a current of optimism and cheap money aimed at resolving Brazil's energy future. Any and all sources of biomass were considered as potential answers to national fuel needs after the shock of the OPEC oil embargo in 1974. Babassu fruit was particularly attractive in that it furnished not just one but several energy products.

Total caloric potential for babassu fruit has been estimated at nearly three million kilocalories (kcal) per ton of fruit (MIC/STI, 1977). This yield is very attractive when compared with sugarcane and cassava, the two other principal raw materials being actively considered as substitutes for imported petroleum (Table 8.1). Ethanol and bagasse or stem material from both sugarcane and cassava were estimated to have considerably lower caloric potential per unit raw material when compared with babassu fruit. Even the caloric value of the ethanol derived from one ton of sugarcane (333 kcal) was less than that potentially obtainable by fermenting the mesocarp from one ton of babassu fruit (410 kcal). In spite of the fact that, on a per unit land basis, sugarcane produces nearly 10 times the calories as babassu, and cassava nearly four times as much, the land productivity factor was relegated to lesser importance. Babassu, as a native forest

Table 8.1. Comparison of caloric potential of babassu, sugarcane, and cassava, per ton and per ha. (MIC/STI, 1977).

RAW MATERIAL	PRODUCTS OBTAINABLE (1 ton raw material)		ENERGY POTENTIAL OF PRODUCTS ('000 kcal)	
	product	**quantity**	**1 ton**	**1 ha.-yr.**
Babassu fruit[a]	Alcohol	80 l.	409.6	1,024.0
	Charcoal	145 kg.	1,058.5	2,646.3
	Gas	174 m^3	696.0	1,740.0
	Oil	40 kg.	344.0	860.0
	Epicarp[b]	120 kg.	451.8	1,129.5
	Total		**2,959.9**	**7,399.8**
Sugarcane	Alcohol	65 l.	332.8	16,640.0
	Bagasse[b]	278 kg.	1,046.7	52,335.0
	Total		**1,379.5**	**68,975.0**
Cassava[c]	Alcohol	90 l.	460.8	11,520.0
	Dry stems[b]	167 kg.	628.8	15,718.9
	Total		**1,083.8**	**27,238.9**

[a] Assumes percentage composition of fruit is 12% epicarp, 23% mesocarp, 58% endocarp, and 7% kernel. Per ha. production is assumed to be 2.2 tons.

[b] At 10% moisture content.

[c] Assumes that one ton of raw material includes 0.5 tons of roots and 0.5 tons of stems at 70% moisture content.

tree, could not be expected to compete in land productivity with sugarcane, an intensive plantation crop having four centuries of agronomic experience applied to its improvement. The supposition was that, with improved management and eventual genetic improvement, babassu could equal if not surpass the alternative biomass sources in land productivity as well as variety of industrial applications of the fuels and other derivative products.

Whatever the rationale, the race toward unconventional energy sources stimulated considerable interest in government and financial circles, and money flowed. Consequently, it behooved venture capitalists to present themselves as the vanguard of the biomass energy field, which attracted creative engineering and managerial talent as well as subsidized investment credits and venture capital from outside the region. It is no wonder that the majority of the traditional industrial community in the babassu zone had little in common with the new wave of entrepreneurs and technical experts who descended upon the scene, and in fact regarded them as a serious threat (Amaral, 1983; interviews with industrialists).

There is a good economic rationale for the oil industrialists' trepidation. Technical innovation in most industries is the harbinger of restructuring. The process of "creative destruction" articulated most eloquently by Schumpeter (1942) promises continued growth in overall economies and a rise in personal real income, but necessarily leaves in its wake the wreckage of prior production methods and social organization.

The process of innovation involves a reduction in average production costs to the innovative industry (Mansfield, 1968). Initially, the industry possesses generally similar long-run average costs over the existing scale range, with some firms obtaining better than average returns due to locational, scale, or quality advantages. With the advent of a major technical breakthrough, those firms which possess proprietary control over the new technology are able to obtain what may be called innovation rents that consist of the difference between the area under their average cost curve and that of the sector as a whole. Such a process of generating innovation rents was discussed with reference to the general case of extractive product industries in Chapter II. These rents are obtained only so long as the technology remains a secret, or costs of adoption of existing technology are prohibitive. Under these conditions, the least efficient firms using the traditional technology will have their market shares gradually eroded as the proprietors of a new technology expand, using the profits they obtain due to lower-than-average costs as a source of investment capital. Eventually, however, information leakage and parallel innovation by competitors will result in adoption of new technology by those who remain in the field, and long-run average costs will settle at those established by the innovative firms.

In the case of babassu, the traditional oil industry has persisted for so long largely due to its importance on the domestic lauric oils scene and to the dominance, until fairly recently, of latifundia over regional land tenures. The latter condition enabled peasants resident on estates to produce babassu kernels under fairly secure access rights as part of the residence contract with landowners. Changing agrarian conditions combined with a decline in competitiveness in final product markets brought about the oil industry's current crisis. The demise of the traditional industry would seem assured if a successful innovative process technology is capable of significantly reducing the costs of raw material as a component of operating revenue.

The process of creative destruction in the babassu industry would not necessarily occur overnight, however. For several reasons, it was not in the innovative industry's interest to force out the oil extractors immediately. First, it was in the political interest of the new firms to avoid making enemies among the local industrial association, largely made-up of oil extractors (Amaral, 1983). High local industrial demand for kernel would take all that the new firms could extract using PSQ technology, despite some initial resistance to dealing with the innovators on the part of oil firms. In practice, however, the majority of the new firms took advantage of business failures among oil extracting firms to incorporate industrial oil in their product lines from the start, by taking over existing crushing plants. While paying lip service to regional preoccupations regarding the future of the oil industry and using as a ploy the potential for higher volumes of kernel at lower cost (FIPES, 1982), the innovators clearly did not intend to rely for long on the existing industry for its kernel markets.

Secondly, during the initial phase of technology and market testing, it was convenient for the innovative firms to obtain the kernel and oil prices prevailing in the traditional industry. Any profit they derived from selling kernels or oil in excess of their operating costs would bolster their ability to both survive and grow. In its fairly rudimentary initial formulation, one of the PSQ projects obtained 42 percent of its gross revenues from sale of oil and press cake, covering nearly all of its raw material costs, which represented 44 percent of gross revenue (FTI, 1982). In contrast, raw material represents nearly 62 percent of oil industry revenues (Table 7.5). The excess revenues derived by the innovative enterprise could thus be freed up for technical improvement and expansion in their nontraditional product lines. For this reason, even though the innovators downplayed its importance, the persistance of the traditional babassu oil industry was critical to the new industry's immediate success.

Recent (Ad)ventures in Babassu Fruit Process Innovation

The most recent efforts to establish babassu fruit processing enterprises, although few in number, range widely in scale and conception. At the top of the scale is the frustrated effort of Sociedade Anônima Agicola e Industrial do Maranhão (AGRIMA) to install a sophisticated facility in the city of Codó in the eastern cocais area of Maranhão. The

AGRIMA venture was conceived as a 900,000 ton per year PSQ babassu fruit processing operation,[6] incorporating technology for production of briquette charcoal, recuperation of tar, methanol and acetic acid from the condensable gases, and fermentation of ethanol from the mesocarp.

At the lower end of the spectrum is the babassu husk carbonization enterprise of the Instituto de Pesquisas Tecnol6gicas (IPT) of São Paulo, operating on the banks of the Parnaiba River in Teresina, Piaui. The IPT project had initial operating capacity to process the equivalent of 10,000 tons of whole fruit annually for briquette charcoal and tar, although plans are underway to triple this capacity in the short-term. The latter was conceived as a transitional technology for eventual linkage with whole fruit PSQ in its more advanced phases. Between these two extremes were several firms which endeavored whole fruit processing as an initial approach, while planning for expansion and process sophistication as markets were won and the innovative industry began to fall into shape.

Raw Material Supply and Process Approaches

All of the schemes developed elaborate mechanisms for coping with raw material supply problems. Some of the factors affecting the costs of raw material transport to a centralized

[6] One knowledgeable informant suggested that the plant's scale was determined by the kernel crushing capacity of the oil processor to which AGRIMA was initially allied, rather than any particular demonstrable scale economies.

processing facility include the fruits' high weight when transported in volume, low native stand productivity, and the relative inaccessibility of the stands, especially during the rainy season. As the firms' scale and radius of operation increase, transport costs grow dramatically. Although one firm developed technology which would be capable of processing fruit using PSQ technology on portable equipment in the forest or at the farm gate, none of the operations which were begun in the 1970s incorporated this approach. Instead, they focused on elaborate collection schemes to assure delivery of their often vast raw material requirements.

At the upper extreme, AGRIMA[7] developed the concept of decentralized collection centers scattered over a four million ha. supply region, at an average distance of 100 km. from the plant. According to the initial scheme, there would be seven centers, each of which would send out its fleet of seven-ton trucks to purchase fruit from a network of autonomous fruit buyers during the five-month peak harvest period. The fruit would be stored on a concrete pad at the collection center until needed for processing, when it would be transported to Codo in 20-ton trucks, by train, or boat. The centers and plant would have a combined storage capacity of 440,000 tons of babassu fruit. This approach was anticipated to enable the

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[7] Data on the AGRIMA case has been derived from numerous interviews with the project's original director, from review of the firm's initial feasibility study (Clan/ AGRIMA, 1972) and of a technical assistance report by FAO (1974), in addition to secondary documentation in FTI (1982) and Governo do Estado do Piauí (1981).

industry to operate year-round. However, setting up the transport and collection system was envisaged to represent fully 3 5 percent of the initial investment requirements of US$ 120 million for the overall PSQ enterprise. The alcohol and acetic acid distilleries together amounted to an additional US$ 80 million. It is not surprising that the AGRIMA scheme has met with no buyers, despite several million dollars spent on technology development, surveys and feasibility studies, most at government expense. It is now unlikely that AGRIMA will pursue its original plans.

In contrast to the existing oil industry, all of the PSQ firms invested in lands possessing dense babassu stands as a strategic supply source and as a locale to develop agronomic methods for palm productivity enhancement. This difference between the PSQ firms and the oil industry can be traced to the formers' view of their enterprise as agro-industrial ventures rather than simply oil extraction from a locally available oilseed. Agro-industrial systems imply full integration with at least a strategic share of the raw material production as well as development of contractual relationships with "outgrowers" (Austin, 1981). The oil industry, in contrast, never perceived itself as part of the agricultural system through which babassu kernel is produced, preferring to view merchants and other middlemen as their suppliers.

In the innovative industry, Tocantins Babaçu (TOBASA) on the frontier of Maranhão and Goiás, brought the concept of integrated agro-industry to its highest ramifications. Part of the TOBASA enterprise involved an attempt at vertical integration with plantation production of babassu palms. This was no experimental trial but, rather, 10,000 ha. were cleared and whole babassu fruit planted with financial support from government reforestation incentives. There does not appear to have been any effort at selection of precocious seed or pre-planting nursery establishment. A visit to the site by Anthony Anderson[8] revealed a very low level of seed viability and high seedling mortality.

TOBASA's approach emphasized the development of an impressive physical plant incorporating alcohol distillation as a use of mesocarp. Investment credits for the factory and plantation components were already depleted when 40 percent of the installation remained to be constructed, and the federal agency (SUDAM) which had financed the enterprise is reportedly unwilling to sink more capital into what may be nothing more than a huge white elephant.

Other enterprises apparently had greater success in enhancing raw material supply security by reducing understory competition and incorporating forage and cattle grazing under palms on their agricultural properties. AGRIMA pioneered in this effort on 29,000 ha. under its control in the Codó area. Agronomist Mariano Mendes surveyed palm productivity and limiting factors for AGRIMA and, later, under government sponsorship, was responsible for guiding field inventories of

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8 **Personal communication.**

four states' babassu stands and production potential (MIC/STI, 1982). Mendes' results from the AGRIMA trials showed some evidence of productivity growth after thinning of native palm stands as described in Chapter VI (MIC/STI, 1977; Mendes & Carioca, 1981).

Efforts to improve palm productivity for whole fruit processing ventures were not limited to AGRIMA. Managers of the Companhia Industrial Técnica (CIT) and of the Empresa Industrial de Bacabal (EIB), both PSQ operations involved in charcoal manufacture and kernel crushing, invested in palm thinning and pasture establishment on their properties in the municipios of Timbiras and Bacabal, respectively. According to an informant at CIT, yields on their 13,000 ha. Timbiras estate initially averaged 1.5 tons per ha. After clearing and pasture establishment, yields increased to 2.5 tons.[9] The same source was of the opinion that there is hence no need to improve the palm genetically because "babassu is perfect."

Despite efforts to assure steady supplies, the whole fruit processors experienced a variety of difficulties in this regard. It is clear from an examination of raw material entry to the CIT and EIB plants at Bacabal during 1980 (Figure 8.3) that whole fruit deliveries were substantially a function of fruit seasonality and rainfall. When fruit were dropping from the bunch, and when rainfall was low (July through November),

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[9] In a round-table discussion on the issue, the same source mentioned figures of up to seven or eight tons as attainable (FIPES, 1982), but this is more conjecture than proven result.

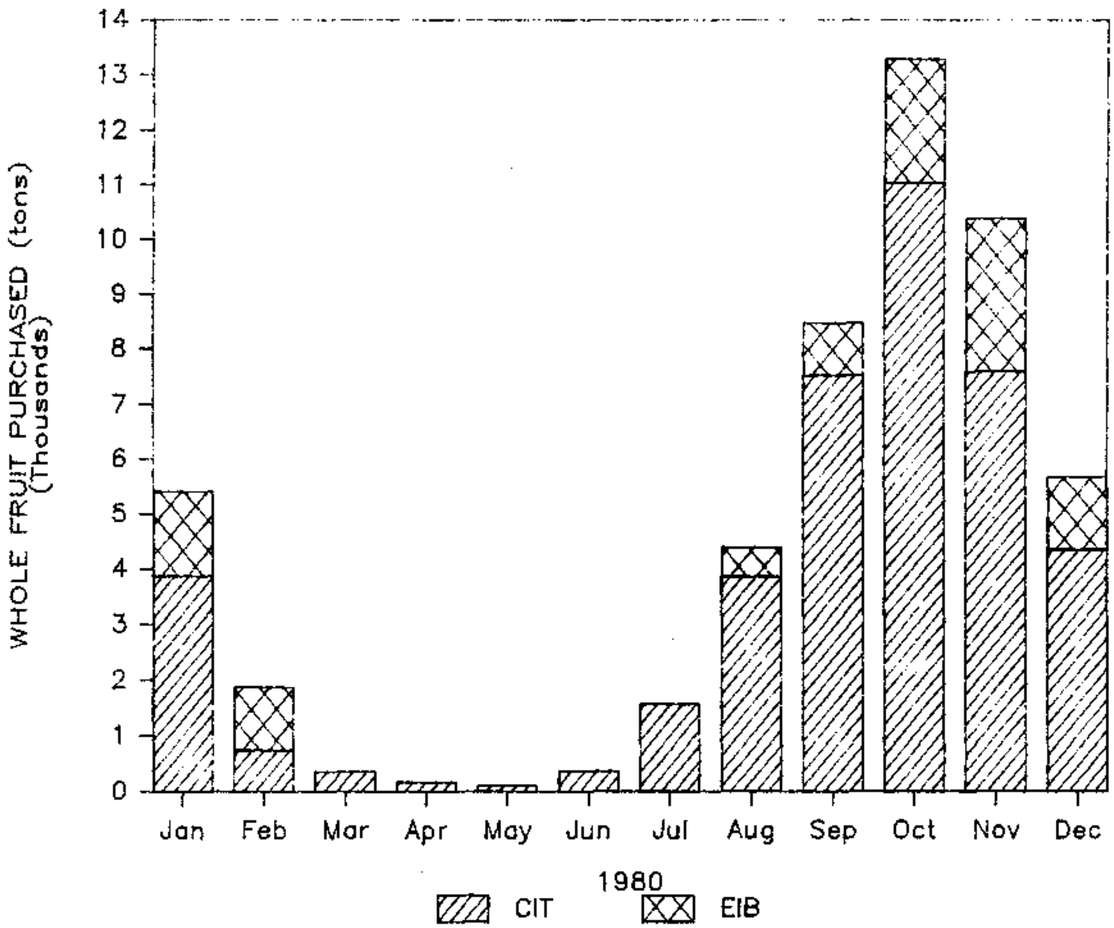

Figure 8.3. Whole fruit purchases by PSQ processing firms in Bacabal, Maranhão: 1980 (Suely Anderson, field notes).

raw material purchasing was substantial. With the arrival of rains in December, and a decline in fruit production, supplies dropped to nearly nil by March. Since their storage facilities were essentially nothing more than open dirt fields, fruit held for any period of time during the rainy season were subject to rapid mesocarp spoilage, seed germination, and predation.

Since 1980, both EIB and CIT have ceased whole fruit processing, preferring instead to purchase charcoal produced by peasants for some minor screening and packaging before resale. They are doing this in hopes of retaining markets for their anticipated return to full production after restructuring equity and making substantial modifications in process technology. CIT has developed an investment project involving scale expansion at their Bacabal plant, storage silos, charcoal briquette manufacture, and starch refining for US$ 35 million. It is the opinion of one recent study (Pick et al., 1985) that this proposed project represents a risky investment since most of the technical problems and market potential remain unresolved, despite probable effectiveness of the firm's PSQ technology.[10]

While several innovative firms put their money directly into PSQ technology, in one important case, that of the IPT charcoal enterprise, the focus was on processing the by-

[10] It is noteworthy that CIT had already received tax reinvestment funds through SUDENE corresponding to US$ 35 million for its first attempts at whole fruit processing (FINOR office, São Luís, Maranhão).

products of manual kernel extraction instead of entire fruit. This approach may be taken to represent an intermediate phase of process innovation, with lesser portent for the traditional industries and rural labor utilization than PSQ implies. After several years of studies, IPT initiated its Carbonization Unit as a pilot project in Teresina, the capital of Piaui, in 1979. This project was financed by the state of São Paulo, to which IPT pertains, and by federal research and development agencies.

The IPT project provides several important lessons.[11] In its initial concept, the plan was to establish a series of "husk collection posts" along the Parnaiba River between Maranhão and Piaui. There, peasants and intermediaries would be able to deposit babassu husks, receiving payment from post operators employed by the firm. Once each month, a tug and barge would collect the deposited husks and bring them to a central processing facility located on the river's bank.[12]

In its configuration as actually constructed, the plant consists of a vertical continuous charcoal kiln with a daily husk carbonization capacity of 20 tons, yielding 290 kg. of charcoal per ton of husk and decanting 270 kg. of tar as a secondary product. Part of the tar was then used as a binding

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[11] Information on the IPT case was derived from a review of the project archives in São Paulo, two visits to the plant itself, interviews with outsiders familiar with its operation, and secondary sources such as Governo do Estado do Piauí (1981) and FTI (1982).

[12] An alternative concept, never seriously considered, involved mounting charcoal kilns on barges to break the bulk and further reduce transport costs.

agent for briquettes made from charcoal fines. These briquettes would be of a size and resistance suitable for bearing the weight of charges in steel reduction columns, a market limitation of nonbriquette babassu charcoal. Charcoal having particles that were larger in size were sold to southern foundries and automobile manufacturers. The only proven market for tar to date was as a substitute for fuel oil in regional applications.

Early on in the IPT demonstration project, problems cropped-up. First of all, the river offered obstacles, as its maintenance as a navigable waterway had been abandoned since the onset of massive federally-sponsored road construction and paving in the Northeast. To operate a tug and barge regularly on the Parnaiba River would mean enormous investments in dredging. Therefore, instead of initiating its activities with the barge, IPT project managers contracted with truckers to purchase babassu husks. This increased transport cost for raw material to the point that serious consideration was given downward-scaling and decentralization of charcoal production.

Decentralized charcoal production gained credence as it became increasingly clear to IPT managers that transport costs were matched by problems of resistance from raw material suppliers. While some landowners of the Parnaiba Valley were willing to engage in marketing of babassu husk, resistance to the sale of whole fruit and husk was marked in other parts of the region, for reasons to be discussed in the next section. Futhermore, an agronomist experienced in the region has noted that the IPT enterprise may in fact have stimulated retention of babassu husks for local processing. As producers became aware that a market existed for babassu charcoal, they became increasingly reluctant to part with their husks. Instead, they began to produce charcoal for sale, whether in excavated kilns (caeiras) on an individual basis or, at a landowner's initiative, in small brick beehive kilns in central estate-level operations. They then marketed the charcoal directly to regional fuel consumers, such as a cement manufacturer in Codó, or to firms like CIT which were eager to maintain their market contacts in southern Brazil.

Responses by Babassu Producers and Landowners

The approach taken to reducing raw material costs and securing supplies by CIT and EIB, the only firms based on PSQ technology which actually reached the operational stage, was to eliminate the intermediary. Da Cunha (1979) found that most peasant producers sold whole fruit directly to truckers (53 percent) or landowners (37 percent). Intermediary purchasing by storekeepers only accounted for two percent of sales of whole fruit, as compared with 66 percent for kernel sales in Bacabal. The PSQ firms made direct contact with landowners to supply babassu fruit, at prices slightly below the going kernel-equivalent rate at farm gate prices.[13]

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[13] After experimentation with price levels between 55 percent and 65 percent of kernel-equivalent prices, CIT increased whole fruit prices to the kernel-equivalent level, reacting to poor supply response.

The landowners in most cases hired laborers to collect fruit, paying them at piece rate. In other cases, landowners rented stands in lots to local entrepreneurs (typically storekeepers or others who could muster resources) who then conducted the collection enterprise under contract to the industry. This was an attractive approach for some modernizing ranchers, who looked askance at peasants entering their properties and leaving piles of broken fruit or burning the husks for charcoal, as described in Chapter VI. Some landowners hence responded readily to the new market for whole fruit.

Others were more resistant to the new technology. In surveys during 1980 and 1981 of landowners and peasant producers in Bacabal, where the PSQ industry achieved its greatest dynamism between 1977 and 1980, the majority of landowners interviewed expressed antipathy toward whole babassu fruit marketing (Anderson & Anderson, 1983). Of 61 landowners interviewed, over two-thirds said they opposed marketing of whole fruits. Of those who did engage in whole fruit marketing, half did so reluctantly, asserting that they felt manual kernel extraction to be more advantageous.

Resistance to whole fruit marketing may have been greater in numerical terms, but the proportion of total land affected by those who engage in whole fruit processing was higher. Those landowners who resisted most fervently were, for the most part, owners of minifundia averaging 34 ha. in size, who engaged in crop production and some babassu kernel extraction on their own account and rented lands to moradores who carried out similar activities. As property size increased, land use on agricultural establishments shifted toward pasture. Landowners of properties over 100 ha. were far more willing to move toward marketing whole fruit. When weighted by the proportion of total land in the sample in different size classes, over two-thirds of total land area was controlled by landowners who sold whole fruits (Table 8.2). The conclusion derived from this behavior is that peasants and small farmers who depend on babassu extraction for an important share of their incomes will be forced, despite their reluctance, to move toward whole fruit gathering as the rural landscape is transformed into pasture.

Table 8.2. Babassu marketing by holding size and proportion of land used for grazing, Bacabal, Maranhão: 1980-1981 (Anderson & Anderson, 1983; Suely Anderson, raw data summaries).

HOLDING SIZE (ha.)	SHARE OF SAMPLE (% of land)	AVG. SIZE (ha.)	SHARE USED FOR GRAZING[a] (% of land)	BABASSU MARKETING (%)		
				None	**Kernel**	**Whole Fruit**
1 - 100 (n = 28)	5.5	34	60	11	82	7
101 - 500 (n = 25)	31.2	218	88	24	28	48
> 500 (n = 8)	63.4	1,385	100	0	25	76
TOTAL (n = 61)	**100.0**	**286**	**77**	**15**	**52**	**33**
Weighted Means[b]		**286**	**94**	**7**	**29**	**64**

[a] Land used either predominantly or exclusively for grazing.

[b] Weighted by share of all land in sample in size categories.

The internal organization of rural production units also affects their owners' willingness to supplant kernel trade with whole fruit marketing. As described with reference to the latifundia of Caxias in Chapter IV, the economic foundation of the traditional enterprises of the babassu zone lies in generation of rents by moradores as well as petty-commodity trade between landowners and estate residents. Although the traditional latifundium is somewhat of an anomaly in the cocais, one landowner in the Bacabal area is quoted by a peasant to have said to whole fruit buyers from CIT:

> I wouldn't sell (whole fruit) to you even to make milk. If I sell you babassu in the husk, then my moradores won't have babassu to break and sell to me in exchange for commodities I sell them. . . . [The peasant went on:] If you have a morador, then the morador breaks the babassu and sells it to you, and you pay him with commodities. You earn a profit from the babassu and from the commodity. . . and enable the morador to subsist. . . When he doesn't have any more babassu to sell you, who are you going to sell your commodities to, to CIT?
>
> [Amaral, 1983: 223-224; my translation]

Thus it was in the interest of traditional landowners to retain the kernel trade, because it both secured a year-round laborforce on the property, and provided a continuous flow of income from commercial goods exchanged with peasants. With a whole fruit enterprise, there was no longer any need to engage in barter. In contrast, ranchers, who had little need for year-round labor except for a few livestock herders, and whose products were all destined for outside markets rather than on-farm consumption, were amenable to the new market for babassu fruit.

The economic foundations for traditional attitudes are being altered as property is increasingly concentrated in the hands of ranchers in the cocais and of agro-industries such as the sugarcane and cellulose businesses in the cerrado. The rationale given by landowners who accept the new babassu technology was predominantly (42 percent) that the collection of whole fruit is more easily supervised (i.e., there was less loss of production due to "leakage" from trespassers), that there was a greater monetary return per unit time by labor engaged in gathering (35 percent), or that a larger proportion of overall fruit production could be marketed with the same labor requirements (23 percent) (Anderson & Anderson, 1983).

Landowners who move toward marketing whole fruit typically have been able to gain a greater proportionate share of farm gate prices from the shift in production and marketing arrangements. During 1980, the last year in which PSQ firms operated continuously in Bacabal, landowners reportedly received from 50 to 60 percent of the farm gate price (Anderson & Anderson, 1983). This division of returns to land and labor was confirmed by subsequent field studies in the same region (FTI, 1982). It represents an increase in the margin that landowners commonly received for kernel when they act as intermediaries, which have been on the order of 25 percent of urban merchants' purchase prices, and even less at the farm gate (Chapter VII).

Part of the reason that an increased share of raw material prices went to landowners is that labor requirements in whole fruit production are substantially reduced from those in manual breaking. Mattar (1979) estimates that the net employment effect of a move toward whole fruit processing would be a reduction of 95 percent in the number of people needed to harvest and process babassu fruit. For each PSQ operation of 60,000 tons capacity, Mattar estimates that nearly 23,000 gatherers and fruit breakers will be displaced.[14] This employment impact will be substantial, even if the whole fruit processing industry provides the economic incentive for an increase in fruit extraction rates. A widespread and rapid adoption of whole fruit processing technology would cause major employment displacement in babassu-related activities. Because babassu gathering occurs during slack labor periods for other activities, there would be little potential for a welfare-neutral labor reallocation to other subsistence activities. Advocates of a shift toward

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[14] This estimate is based on two sets of assumptions. First, the number of people engaged in gathering and manual breaking of babassu fruit is based on an assumed annual per-household production rate of 500 kg. of kernels, estimated as equivalent to 8.3 tons of fruit (at an average fruit-to-kernel ratio of 16.7:1). Each household is assumed to have an average of 3.35 members involved in fruit gathering (25 percent of their time) and breaking (75 percent) during 100 days of harvesting per season. The total laborforce needed to supply kernel equivalent to 60,000 tons of fruit would be over 24,000 people. My surveys suggest that household annual kernel extraction rates actually average about 700 kg. per year, employing a somewhat smaller number of people per household over a longer time period. The estimated allocation of time between harvesting and fruit breaking is the same as my own. Fruit gathering for a 60,000-ton PSQ enterprise would engage what Mattar estimates as a maximum of 1,200 people over a 100-day period. Even if kernel extraction productivity were to be double what Mattar estimates, the employment displacement would be on the order of 11,000 persons for each PSQ factory established.

PSQ technology assert that the labor displacement impact will not be severe, because whole fruit processing will generate new jobs in stand management, fruit transportation, and access road maintenance, as well as potential employment in forward-linked enterprises making finished products from babassu fruit components. Except for unskilled labor in maintenance activities, however, it is unlikely that peasant farmers would find work easily in such new occupations. Proponents of PSQ also assert that the remaining collectors' incomes will be multiplied as much as sevenfold by gathering fruit rather than extracting kernels (FIPES, 1982; Governo do Estado do Piaui, 1981). In theory, this would enable the better-remunerated workers who remain to compensate some of those affected by the change.

The explanation for the greater remuneration of labor is that the amount of fruit collected by the same number of workers, in kernel equivalent, would far exceed the kernels those workers could extract in the same time period. While the data from Lima Campos and Chapadinha average less than four kg. of kernels in one day's work collecting and breaking (Chapter V), estimates range from 25 to 50 kg. per day in kernel equivalent for whole fruit gathering (FAO, 1974; FTI, 1982; Anderson & Anderson, 1983). This would shorten the time needed to harvest output from a given farm's babassu stands as well as increase the proportion of fruit actually collected. This provides the rationale for PSQ technology being a means to assure greater utilization of a "squandered" resource.

It might be thought that the opportunity to gather fruit even at slightly lower kernel-equivalent prices would be preferred by the collector, who could gather from six to 10 times as much whole fruit as could be collected and manually broken in the same day's work. However, a favorable response has not been registered among producers. On the contrary, none of the landless household heads interviewed by Suely Anderson said that they preferred whole fruit gathering over manual extraction of kernels (Anderson & Anderson, 1983). Under conditions where kernel extraction is still an available option, peasants who have a choice between whole fruit gathering and manual kernel extraction choose the latter. Where whole fruit gatherers are given the option to retain a share of the fruit gathered as payment, they preferred to expend the additional labor to break fruit so as to sell their kernels rather than selling their share in the form of whole fruit (Anderson & Anderson, 1983).

There were two principal reasons offered by landless producers for their disapproval: (1) upsetting of income stability, and (2) loss of subsistence products derived from the fruit. The majority (57 percent) said that collecting whole fruit would limit the stability of income flows to subsistence production (Anderson & Anderson, 1983). As we have seen in Chapter V, babassu kernel output complements shifting cultivation and wage labor among landless producers in several important ways. By providing a source of cash or in-kind income generated by women and children whose labor is not critical during the period between annual crop harvests, babassu kernel extraction provides a "subsidy from nature" to subsistence production. However, it is not obvious from an analysis of labor allocation in the traditional crop calendar why peasants would feel that their income stability would be endangered by engaging in whole fruit gathering rather than kernel extraction. Timing of labor opportunities in whole fruit gathering is the same as in kernel extraction. The harvesting of whole fruit could provide a commensurately large or greater amount of income. Hence whole fruit production would appear to lend itself well to complementing small farmer agriculture if women and children are to be the principal workers involved.

Although proponents of whole fruit processing technology assert that collection could be carried out by women and children whose labor is not critical for land preparation (FIPES, 1982), reality does not appear to bear out their assertion. In a study of household income formation in subsistence production, da Cunha (1979) surveyed families in Bacabal, Maranhão with the aim of assessing the labor allocation and employment effects of a change toward babassu fruit gathering (Figure 8.4 and Table 8.3).[15]

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[15] The da Cunha study included a comparison of Bacabal with Chapadinha and Caxias households. The data from the other two municípios were not analyzed for the present study because (1) they had not experienced a shift toward whole fruit processing, and (2) income and labor allocation behavior in these two municípios cannot be adequately compared as "base cases" with those for Bacabal because of vastly different land productivities and hence labor requirements per unit output. Furthermore, the social organization of rural production

In Bacabal, where the majority of whole babassu fruit-buying activities were concentrated from 1977-1980, numerous rural households contributed to labor demands in fruit gathering. Da Cunha's data, based on interviews only with babassu producing families, show that 98.5 percent of all households involved in some aspect of babassu production devoted some of their labor to whole fruit collection during 1978. This, in fact, exceeded the proportion of households who reported kernel production during the same period. However, Figure 8.3 shows that men over 15 years of age were responsible for over three-quarters of all "man-equivalent" household labor devoted to whole fruit gathering.[16] If we assess labor allocation within sex and age groups, women and children spent less than 12 percent of their combined productive time in whole fruit gathering, while kernel extraction on average took up nearly 77 percent of their time. In contrast, men devoted only seven percent of their time to kernel extraction.

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enterprises has been shown in this study to differ substantially between cocais (Bacabal) and cerrado (Chapadinha and Caxias) sub-regions of the babassu zone. For these reasons, it makes little sense to compare households between these three areas as if the only factor which distinguishes them is a different form of babassu product marketing, the basis for da Cunha's comparison. Ideally, a comparison between households which are and are not engaged in whole fruit processing in the same region should be undertaken to assess the welfare impacts of a shift. While this was one of the original objectives of my research, the absence of significant activity in the PSQ industry during my stay made such a comparison impossible.

[16] This figure may be biased upward slightly by the weighting scheme used to quantify "man-equivalent" labor, which placed a lesser weight on females' and children's than on adult male's time. Because I was not able to find a description in da Cunha's study of the weighting scheme he employed, I am unable to assess the degree of bias present in the data.

Table 8.3 shows that average cash income per man-equivalent day in whole fruit gathering was significantly greater than that derived from kernel extraction, even when the value of charcoal and other by-products derived from babassu and subsequently sold are included in the latter. However, the proportion of total household labor allocated to this new activity was only a bit better than half that devoted to kernel extraction.

If the alternative of fruit gathering was so lucrative, why did people continue to devote most of their time to manual kernel extraction? One reason appears to be a more restricted production organization for whole fruit gathering when compared with that for manual kernel extraction. Most whole fruit gathering employment took the form of wage labor under the supervision of a landowner or stand renter. Households may prefer to continue allocating labor to kernel extraction, even though it may be less remunerative on an hourly basis, because it provides a more even flow of income over the year and can be carried out at the producer's convenience. While stockpiling fruit for gradual sale over the year might appear a solution, this option is usually not available to peasants employed on a piece basis to gather fruit as daily wage workers on land belonging to others.

Second, the income from kernel sale is earned principally by women and contributes directly to family upkeep by being exchanged immediately for food and wage goods. Research on other activities where female labor is supplanted by that of

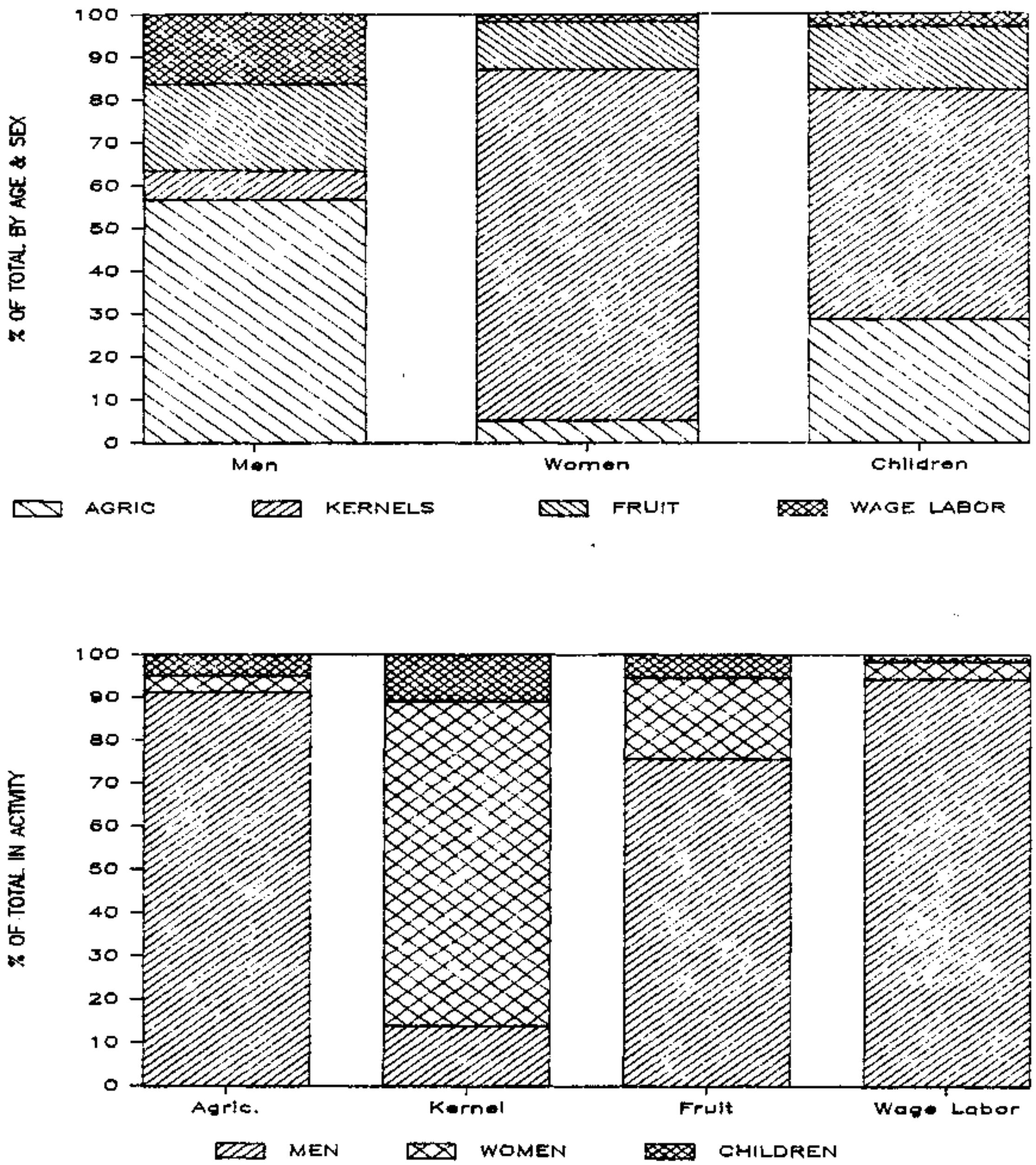

Figure 8.4. Household labor allocation in man-equivalent days by age and sex, Bacabal, Maranhão: 1978 (da Cunha, 1979).

Table 8.3. Labor productivity, Bacabal, Maranhão: 1978 (da Cunha, 1979).

INCOME SOURCE	SHARE OF TOTAL LABOR[a] (%)	SHARE OF CASH INCOME (%)	CASH INCOME PER DAY[a] (Cr$)
Agriculture	40.0	24.3	27.44
Babassu kernel extraction and charcoal mfg.	31.5	33.4[b]	47.95[b]
Babassu fruit gathering	17.3	24.3	63.54
Wage labor	11.1	11.0	44.85
Subtotal	**100.0**	**93.0**	**42.04**
Other activities		7.0[c]	n.a.

[a] Labor is calculated in man-equivalent days, including men over 15, women over 15, and children.

[b] Original figure incorporated sales of babassu by-products, hunting and fishing, and rental income. Da Cunha notes that, among these sources, babassu by-product value predominated. Hence, 66.7% of the undiscriminated value of income from other sources was included among babassu kernel and charcoal.

[c] Of the additional 7%, a good share is obtained from pensions (42%), and the remainder is due to estimated income from rental, hunting, and fishing. The latter had no labor allocation figures associated with them.

men has shown that the result is a loss in household nutrition and other indicators of well-being (Beneria, 1979). Women's fear that their most important source of cash income would be eroded by a change to whole fruit gathering may have affected behavior.

Finally, because the whole fruit processing industry is still in its infancy, and some landowners are resistant to marketing whole fruit, demand for labor to gather whole babassu fruit is still restricted. It is probably true that until an innovative babassu industry is fully developed, households will continue to allocate available labor to both whole fruit gathering and kernel extraction. Women will likely devote more of their available time to whole fruit gathering as transition in the industry reduces demand for kernel from peasant production. However, expulsion of the resident laborforce from agricultural enterprises will make babassu gathering less a complementary aspect of an overall production strategy by peasant households, transforming it into merely one of the limited sources of wage employment available in rural areas of the babassu zone. Given increasing difficulties in obtaining access to land for shifting cultivation, men will in all probability remain the principal wage-earners in babassu gathering.

Another important rationale for the greater labor allocation to kernel extraction is that part of the kernels and all the by-products remain for household consumption and some sales. Of the landless producers interviewed in 1980 by Suely Anderson, 40 percent said they disapprove of whole fruit processing because the availability of subsistence products would suffer as a consequence of the change (Anderson & Anderson, 1983). While the benefits from the subsistence products derived from babassu are small if valued at local market prices (they constituted on average only nine percent of noncash income for the households interviewed for the present study, based on data in Table 5.4), the loss of these products represents a substantial opportunity cost.

In traditional areas, where the kernel is typically the only portion of the fruit marketed, the remaining components are used principally for charcoal and animal feed (Chapter V). If the peasant farmer has to substitute fuelwood for charcoal, there is a significant risk of forest degradation and eventual fuelwood scarcity with rural population growth. The alternative would be for the peasant to buy babassu charcoal back from the industry after processing, or to purchase other fuels such as kerosene or liquid petroleum gas for cooking requirements.

There are institutional constraints against use of substitute fuels, however. Peasants would have to obtain credit to buy kerosene or gas stoves, but credit is restricted to those who possess collateral or a _patrão_ willing to assure repayment. Furthermore, ready supplies of commercial fuels are only found in towns, which are often inaccessible. The only real alternative to babassu charcoal is fuelwood, which is already in short supply, and needed to supply nutrients and provide fencing materials for crop protection. A shift of babassu charcoal into the realm of circulation from its current subsistence use would have secondary consequences for the crop production system and survival of the palm forest. There will thus be a real net cost to producers in giving up by-products of manual extraction for commercial fuels. The price of the fruit fails to incorporate the opportunity costs engendered by sacrificing these by-products which have subsistence uses.

In areas which have become more closely linked with urban markets and where agrarian transformation has been most pronounced (such as Bacabal and surrounding municipios of the Cocais), some babassu gatherers obtain a significant income selling the by-products of manual kernel production. Of the producers interviewed in Bacabal by da Cunha (1979), it is estimated that at least six percent of total cash income was obtained from sale of babassu charcoal and husks. This figure is closely matched by my survey, in which respondents in both Lima Campos and Chapadinha reported that charcoal sales account for 5.2 percent of their total cash incomes. The sale of whole fruit would eliminate this added source of income unless producers were able to obtain access to babassu stands from which they could extract additional fruit to satisfy their fuel needs. To do so would require that they allocate additional labor to the pursuit, which would also present some opportunity costs.

Despite the possible net opportunity costs entailed by loss of subsistence products, it appears that employment displacement will be the most significant social cost of a shift to whole babassu fruit processing. The final section of this chapter summarizes the nature of changes brought about by the incipient phase of this innovative industry.

Effects on Resource Access and Distribution

For those who agree that employment reduction will inevitably reach considerable magnitude as the result of a shift to whole fruit processing, there is some hope expressed that kernel extraction would persist during the period of technical innovation in the processing industry, which would cushion the employment impacts (FTI, 1982). However, the attractiveness to landowners of whole fruit marketing has apparently motivated a permanent alteration in methods of babassu production and resource access. These changes, compatible with the broader alterations in rural enterprise organization and land use underway in the babassu zone, are incompatible with peasant agriculture and extractivism.

None of the whole fruit processing firms was operating at full capacity during the period my field research was in progress. Nevertheless, their four years of wide-ranging efforts to secure supplies of whole fruit from 1977 through 1980 and their continuing purchase of charcoal and husks had brought about lasting changes in production relations for babassu collection as well as in the distribution of returns from product marketing.

Landowners who have converted their operations primarily or exclusively to pasture have found it convenient to alter arrangements for collection and marketing of babassu. Among the more prominent production schemes being adopted is that of consignment of the fruit collection enterprise to one or more of the rancher's herdsmen. These in turn guard the perimeters of the properties from incursions by collectors seeking free entry. The herdsmen then contract labor on a daily basis to gather fruit. In this system, the returns from babassu constitute a substantial portion of the herdsmen's salaries. They thus have an incentive to pay the minimum possible rate to collectors.

In the absence of demand for whole fruit, the herdsmen or landowners consign the fruit to collection centers, whether on their property or in a nearby community. Individual entrepreneurs, sometimes financed by a kernel or charcoal buyer, set up collection centers as a mini-factory. There, women are engaged to break fruit manually. In payment, they are entitled to half of the kernels they extract, but must sell these to the collection center operator at his price, usually 10 percent or more below the going local kernel price. The women are often also required to convert the husks to charcoal, which remains the property of the center operator.[17]

In other areas, the growing market for charcoal and fruit husks has provided an incentive for landowners to insist that these by-products now become theirs as rent for the right of access to fruit collection. A more recent phenomenon is that of large-scale purchases of whole fruit to be used for fuel in other states without removal of the kernel. Such buyers are having increasing success in contracting for supplies.

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[17] In some cases the charcoal production is done by others contracted by the operator but, in any case, remains his property as a marketable commodity rather than being retained by peasants as fuel.

Landowners of substantial babassu groves in pastures are reported to find it more convenient to harvest fruit off the ground with front-end loaders rather than paying workers to collect at piece-rate. Even where they continue to be employed, gatherers of whole fruit are rarely allowed to retain fruit for subsistence purposes.

The results of the studies reviewed in this chapter point to increasing dependence on babassu for incomes that are being constrained by expulsion from agriculture. Yet this income is being earned by men, rather than women. The technical innovation in the babassu industry demands that fruit be gathered in large volume (up to two tons daily per worker) and transported in continuous flows to a central processing unit rather than broken manually at home and sold when convenient. Granted that women would be just as capable as men of accomplishing the task, the reduction in employment needs for whole fruit processing over manual kernel extraction will likely result in less babassu income being controlled by women.

However, it is not the innovation in the industry alone that is causing problems of resource access and distribution in the babassu zone. Conversion of land use to pasture and expulsion of peasants from rural properties, occurring in tandem with the innovative industry, imply drastic alterations in rural employment and income distribution. The distributive implications of the transformation in babassu processing technology are eloquently summarized by rural workers union members:

> Everybody suggests that babassu is not profitable, that babassu impoverishes everyone. Babassu put everyone out on the street, but. . . it was the livestock projects that were implanted on top of babassu stands that were cut down. . . How many people have gone hungry because of these palms that have been cut down to the ground?
>
> How can we say that we're going to modernize whole fruit processing, and that will make the landowner, the great proprietor, preserve babassu stands? How can we say that this is going to mean better conditions for the _caboclo_ [peasant]? . . . It's going to worsen the situation; it means more unemployment, on account of a product that, like it or not, is natural. . . We have to make better progress, industrialize, change the systems that have been there for so long, but we have to study also some means to employ people, with the goal that . . . you don't take this all at once from the _caboclo_. because it means another form of mortality, another system of hunger. Let's pay attention to this because I will never concede that all of a sudden with this whole fruit, this is going to give income to the _caboclo_. This income is going to enter into the capitalist's pocket.
>
> This is the problem that I see. Now, your proposition I accept — industrialization is an easier means to do the work. I want to see this done and also that we work to help the suffering people that are going to end up without jobs. Maranhão is the only state where men are being imprisoned and beaten for wanting to work, the only one. . .[18]

With this last cry from the earth for a just solution to the babassu problem, this chapter concludes presentation of issues surrounding industrial processing of babassu fruit. The next chapter summarizes the findings presented elsewhere in the study, and seeks to evaluate alternative solutions proposed to resolve pending problems of resource development, property rights, and employment in the babassu zone.

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[18] Representatives of the Federation of Agricultural Workers of Maranhão, quoted from round-table discussion in FIPES (1982). My translation.

CHAPTER IX

ALTERNATIVE DEVELOPMENT PATHS FOR THE BABASSU INDUSTRY

Synthesis of Research Findings

The historical underdevelopment of the babassu sector and its current crisis reflect the inherent economic rationale of the extractive system. It is clear from the examination of process innovation in Chapter VIII that there are conflicting objectives between actors involved in the existing industry and those promoting technical innovation. Similarly, the changing dynamic of the rural economy as a whole is critical to development prospects in the babassu sector. Only by examining the context within which industrial innovation is taking place is it possible to gauge the social equity consequences of the change. This chapter draws together the various strands to provide a comprehensive view of the future of the babassu economy, and to offer a preliminary analysis of technical alternatives.

Alternative Hypotheses on Babassu Extraction

The relative importance of babassu income, both cash and imputed, to landless peasants and small farmers of the cerrado areas studied in Chapter V has been shown to be substantially greater than that for survey respondents in the cocais. This finding supports one research hypothesis suggested by analysis of babassu kernel extraction rates between the two regions

(Chapter III): that babassu is not as critical a resource for cocais farmers who cultivate better soils under higher rainfall regimes than is typical of the cerrado. Babassu extraction rates would be considered a result of rational economic behavior in allocating scarce labor to the most productive activity. This hypothesis suggests that babassu stands are underexploited in the cocais because other resources make up the deficit met by babassu in the cerrado. Ceteris paribus, the impact of a technological change toward whole babassu fruit processing in the cocais would therefore not be as severe in social terms as it might be in the cerrado, where close to two-thirds of annual babassu production is already being harvested, and where employment in babassu-related activities plays an essential part in household income formation.

However, a parallel finding of the research on small farming systems in Chapter V points to considerably greater dependence on babassu income by landless households wherever they may be located. As a household's total income from all sources declines, the share of that income derived from babassu extraction increases. Particularly in the cocais region, where massive shifts in land use toward livestock ranching have been accompanied by peasant expulsion and enclosures, landless peasants are subject to constraints on access to land resources. This has the effect of making them more reliant on babassu to complement meager agricultural production and wage incomes, while at the same time forcing them to cut down the very palms on which they depend in order to produce annual crops. Such conditions I have described in this thesis as a tragedy of the non-commons.

The non-commons hypothesis holds that underexploitation of babassu in the cocais is due not to peasants' efficient resource allocation in response to relative factor endowments but, rather, to changes in property rights resulting from shifts in agricultural enterprises. Restrictions in land for shifting cultivation as well as in access for babassu fruit collection place added burdens on the resources that remain available for peasant exploitation, reducing the capacity of these resources to sustain the peasant population under current technology. Within this context, technical innovation in babassu processing could have severe additional social welfare consequences which would not be adequately compensated by the beneficiaries of technological change.

Heuristic Analysis of Industrial Development Impact

At the present juncture in the process of agro-industrial change in the babassu zone, neither of the alternative hypotheses detailed above wholly explains observed conditions. Further, it is not clear whether it is pasture expansion or industrial innovation that is most influential in determining potential welfare outcomes. It is therefore necessary to evaluate the impact of whole fruit processing in combination with that of pasture expansion to determine which has the greatest influence. In the analysis below, I evaluate the potential for a whole fruit processing industry to fulfill its claims for resolving the babassu problem. To simplify this evaluation, I have assumed for heuristic purposes that babassu extraction rates can be explained under different conditions by one of the two alternative hypotheses explored above. That is, the rate of resource exploitation is treated as a function of either efficient producer behavior or a non-commons tragedy.

To do this, I assume that all babassu stands possess equivalent fruit productivity. What would be the impact of introducing the innovative industrial technology in different areas of the babassu zone which vary in terms of both the current level of babassu extraction and their agro-pastoral development potential? The different combinations at the extremes for both conditions are shown in Figure 9.1.

In the low extreme for both conditions, represented by the upper-left quadrant of Figure 9.1, the babassu stands are subject to low extraction pressure, and there is also very little motivation for development of modernized agricultural or pastoral production systems. One example of such an area is the baixada region of the babassu zone, where estimated fruit collected for kernel extraction only represents 31 percent of the total output from native stands (Table 3.8.).

Agro-pastoral development in the baixada has been impeded for many years by poor access conditions and seasonally inundated rangelands which have historically been under common management. Current development processes underway in the

BABASSU EXTRACTION RATE

		Low	High
AGRO-PASTORAL DEVELOPMENT POTENTIAL	**Weak**	(1)	(3)
	Strong	(2)	(4)

Examples: (1) Baixada

(2) Cocais/Pre-Amazonic Zone

(3) Chapadinha/dry cerrado

(4) Caxias/Parnaíba River Valley

Figure 9.1. Typology of contextual conditions affecting babassu industry development.

baixada suggest that these conditions will not remain indefinitely. Conversion of some upland areas to pasture, enclosure of formerly common grazing lands by private initiative, and the beginnings of mechanized crop production are apparent in some parts of the baixada. These trends could reinforce current net outmigration of peasants, who comprise the poorest among all rural inhabitants in Maranhão.

Development of an industry using whole babassu fruit as a raw material in the baixada holds some promise as an equitable as well as efficient strategy, both because the underutilized fruit production represents a "new" resource (Blair et al., 1983), and because there are as yet few alternative land uses which compete with the palms. Furthermore, my small farmer surveys in the baixada, though incomplete, demonstrate that there is little utilization of babassu fruit husks for fuel (Table 5.6). It is probable that whole fruit processing at an industrial scale in the baixada would not deprive peasants of subsistence benefits obtained from charcoal, as it might in areas where most husks are employed for this purpose.

Nevertheless, it is important to take into account that industrial development in the Baixada would be substantially impaired by problems of market access. If access were to improve, furthermore, one of the principal barriers to agro-pastoral development would also be removed, thus lessening the prospect that industrial innovation would lead to an equitable distribution of rewards. In the latter instance, the Baixada conditions would move toward the lower-left quadrant of Figure 9.1., where, although the babassu extraction rate remains low, agro-pastoral development potential has intensified.

The condition toward which areas like the Baixada would move given increased market access has already been achieved in many parts of the Cocais and areas of Maranhão's Pre-Amazonic zone. Laced by three major rivers and possessing fertile, alluvial soils, these areas were the most recent to be colonized as migrants from other Northeastern states fled drought in the semi-arid lands to the east. Once they arrived, many colonists were able to gain a foothold on unclaimed lands for shifting cultivation. Their activities enabled the spread and eventual dominance of babassu forests that now cover over 80 percent of the land in some areas.

Highway construction and the laying of the new Carajás railroad now serve to link these new lands, previously lacking in overland transport access, to urban markets (see Figure 3.5). Once the area was opened up, land concessions to livestock ranchers forced squatters off the properties; they then served as the vanguard in the advancing frontier to the west (Velho, 1969; Wagner, 1981a). Population density in former frontier areas for this reason remains quite low. Even in the longer- settled cocais subregion, the rural population density per unit area in arable land is only slightly higher than that of the far less productive cerrado (Table 3.2). It is safe to say that the low babassu extraction rates in this region (only about 10 percent) are therefore more a function of the non-commons than of efficient resource allocation on the part of peasant producers. Even if peasants here do not require kernel income as much as they do in the dry cerrado, it appears that the low extraction rates in this area are a result of enclosures and constraints on collection rights.

In areas such as those represented by the lower-left quadrant, high babassu production potential is impeded by the decisions of ranchers on the frontier to clearcut palms and suppress seedling growth rather than cope with the complexities of a palm-pasture system. Should a new processing industry motivate landowners to retain babassu palms by offering attractive purchase contracts and facilitating labor management for collection, such an environment will be propitious to industrial development. Landowners attracted to marketing whole babassu fruit are precisely those whose operations are becoming more capital-intensive and who have expelled the resident laborforce. Under these circumstances, therefore, it is pasture conversion which leads the process of transformation in babassu production relations.

There are, however, important reasons why an enterprise based on whole fruit processing might not be viable even under the propitious conditions represented by the lower-left quadrant. While the industry will not have serious social welfare impacts of its own, the very fact that labor use and peasant settlement are restricted in these areas implies that there will be problems in securing a reliable, low cost laborforce for seasonal babassu harvesting. Importing male workers from areas where these constraints do not exist will also be difficult because the peak babassu collection period coincides with that of agricultural land preparation. The laborforce would therefore consist of the mass of rural landless who have flocked to urban areas in the babassu zone as access to land for shifting cultivation has been progressively curtailed. Such a laborforce may be more costly to hire-in seasonally than resident household members have been in the past. Babassu collection will have to compete with sporadic agricultural, gold mining, and urban wage employment for workers. Alternatively, ranchers could employ additional herders whose families could be employed during the babassu harvesting season in fruit gathering. However, the costs of permanent wage employment have in general been reduced to the bare minimum on federally-assisted ranches which are more vulnerable to scrutiny regarding compliance with labor statutes than are latifundia. Herders will probably continue as contractors of nonfarm labor who will be for the most part migrant workers.

In the long term, moreover, degradation of native babassu stands managed over either improved pastures or short fallow shifting cultivation will threaten the ability of the industry to secure adequate raw material supplies. Ranchers' suppression of seedlings in pastures to reduce competition with grasses will gradually bring about senescence of pasture stands of babassu. Supplies of whole fruit would become more and more dependent on forest reserves and areas used for shifting cultivation. However, as pastures expand, the fallow cycle for crop production in babassu stands is shortened, reducing the palms' sustainable yields. With all these caveats, it would seem more appropriate from both efficiency and equity perspectives for the industry to focus on areas where competition for land is less intense.

Areas characterized by conditions in the upper right quadrant of Figure 9.1 exhibit high current babassu extraction rates, but low intensity of agro-pastoral development due to poor soil and moisture conditions. Such areas are well represented by cerrado conditions such as those present in

Chapadinha, Maranhão. In the areas around Chapadinha, crop production by landless peasant households resident on latifundia is carried out in lowland areas, where babassu thrives, while cattle and small livestock are grazed on unenclosed upland savannas. There is as yet limited interest in agro-pastoral investment in these areas, although there has been some success with mechanized rice and cassava cultivation, and some attempts to develop irrigated pasture for breeding of improved cattle. Although overall population density is low in the cerrado (Table 3.2), the arable land constraint makes babassu a crucial resource. For this reason, the majority of babassu stands are already being fully exploited (61 percent of fruit production is harvested).

Since the peasantry of the cerrado rely intensely on these resources for their survival, a shift toward whole fruit processing here could have considerable social welfare impact. On the other hand, industrialists would not likely be drawn to such an area, because the high current extraction levels and traditional enterprise organization are not promising from the standpoint of generating substantial whole fruit supplies.[1] In contrast to the situation described for the Cocais and Pre-Amazonic areas, social impacts associated with whole fruit processing under the conditions described by

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[1] It is notable, however, that the 900,000 ton capacity whole fruit processing facility planned by AGRIMA would have derived the majority of its raw materials from cerrado properties (Chapter VIII). The potential problems in generating substantial supplies of whole fruit in the cerrado are another reason to suspect that such an enterprise would not be successful.

the upper-right quadrant of Figure 9.1 are led by industrial innovation rather than by agrarian change. Alterations in processing methods for babassu, if generalized in such regions, would imply significant employment displacement.

Even if paternalistic landowner-peasant relations were to continue in those areas of the cerrado subject to little competition for land use, channeling of any babassu fruit to a central industrial facility would affect the complementarity of babassu extractivism with small farm enterprises. Since most babassu stands are already exploited near their sustainable production limits, commercialization of whole fruit would reduce the output available for manual kernel extraction and subsistence product uses. The reduced labor requirements in whole fruit gathering would imply that the partitioning of benefits from babassu industrialization would be limited to a smaller number of producers. The remainder would not be compensated for their loss, and, because any use for the displaced labor would not provide commensurate returns to peasant production, such a change would result in a net decline in peasant households' incomes.

One probable result would be increased out-migration from such areas by landless farmers already subject to deprivation during drought periods. Another result would be increased pressure on the already fragile agricultural resource base to fill the gap from babassu income foregone. This might eventually lead to reduced fallows and degradation of palm stand productivity in a fashion similar to that occurring in the cocais as a result of property rights limitations. Both end in a tragedy of the non-commons.

Finally, there is the possibility that the heretofore low land use intensity of agro-pastoral enterprises in areas where traditional latifundia dominate will be altered in response to growth in demand at the national level for new products. Such conditions, which are typical of the Caxias region described in Chapter IV, are represented by the lower-right quadrant in Figure 9.1, where both babassu extraction rates and agro-pastoral development potential are high.

With the onset of mechanized agricultural development geared to supply sugarcane and cellulose processing industries in the area around Caxias, traditional patterns of labor and land use are undergoing rapid shifts in response to demand for the new products. Commercialization of whole babassu fruit in association with curtailment in agricultural land available for peasant production would complement the dominant trend toward seasonal wage labor utilization of urban migrant workers. The combined action of land use and agro-industrial change imply dramatic employment impacts. However, as areas where sugarcane is to be planted coincide with those most densely forested with babassu stands, the movement toward land conversion for mechanized crop production in such areas would have the effect of reducing babassu production potential. The fact that native palm stands do not cover large contiguous areas in the cerrado also will act to reduce the viability of a centralized fruit processing industry, owing to high transport costs. The already obvious willingness of babassu oil producers of Caxias to move toward soybeans as a raw material suggests that this area has already begun to experience reductions in kernel availability. Since the region is one where most babassu fruit is already being extracted, a whole fruit processing industry is not likely to stimulate increased output except by supplanting kernel extraction with whole fruit marketing. As has been shown in Chapter VIII, such a displacement cannot help but have severe employment impacts.

Analysis of Technical and Institutional Alternatives

The heuristic treatment above of the potential impacts of a whole fruit processing industry under a variety of contextual conditions reveals significant reason for policy concern on the part of Brazilian decision makers. The babassu zone, historically one of the principal rice and vegetable oil producing regions of Brazil, and a land offering opportunity for victims of drought in the semi-arid Northeast, is rapidly being transformed with emphasis on enterprises which demand little labor, and which have promoted drastic changes in land use. These changes tend to constrain the ability of peasant households to remain in agriculture.

Among the policy positions which have arisen with respect to the babassu problem, it is often heard that the development of a whole fruit processing industry should not be permitted because it will have severe impacts on the peasantry. In counter-argument, it may be reasonably questioned whether government should deny financial or technical support to industries based on whole babassu fruit to guard against negative social impacts, yet do nothing to counteract other changes impinging upon social equity in the babassu zone. The remainder of this chapter evaluates some of the alternative policies being considered as an effort to achieve partial solutions for the babassu problem.

Under only one of the set of circumstances described in the previous section does it appear that a whole fruit industry might have the potential on its own to promote an efficient _and_ equitable solution to the babassu problem. Such areas, exemplified by current conditions in the Baixada of Maranhão, are isolated and present obstacles to market access. The new industry appears to be compatible with altered labor and land use patterns in recent areas of settlement and pasture development where babassu has emerged in succession as dominant forest vegetation. Yet, there may be serious constraints to industrial viability where babassu extraction is planned within conditions of pasture development pressure. Such constraints arise from problems of securing an adequate low-cost seasonal labor supply and increasing costs of raw material that would arise from long-run degradation of palm stands over pastures or subject to diminished fallow cycles. In response to these problems, one policy option being actively pursued is that of genetic improvement of babassu as a crop for intensive plantation culture or for dissemination to ranchers, enabling them to gradually enrich native stands as palm productivity becomes degraded through senescence.

Genetic Improvement of Babassu Palms

Response to low native stand productivity as a factor inducing landowners in many areas to deforest babassu palms, has led the Brazilian government in association with United States collaborators to embark on a long-term program of genetic improvement of Orbignya species (Balick et al., 1985). This program involves wide-ranging collections of specimens from populations as far away as Mexico and Colombia as well as throughout Brazil, and the establishment of "germ plasm banks" where seed from these specimens are planted to provide the raw material for selection and breeding of improved varieties (FAO, 1983). One rationale for this concentrated effort is that some precocious populations of babassu palms as well as other economically promising tropical forest species are threatened with extinction with the rush toward tropical land development (NAS, 1976). If genetic diversity is not captured as a pool for future human needs, there will be irreversible losses.

The potential for improvement in babassu palms' productivity is considered promising for several reasons. First, palms of the genus Orbignya appear to hybridize spontaneously with other palms of the same and related genera such as Attalea and Maximiliana. This implies high genetic variability.[2] Secondly, many of the palm's characteristics such as germination and maturing rates, fruit yield and composition, appear to be under genetic rather than environmental control (Anderson, 1983). It would thus be theoretically possible to manipulate these factors to develop improved species possessing characteristics desirable for economic reasons (e.g., higher kernel content, softer endocarp, higher yield, etc.).[3]

On the negative side, however, are several factors which represent formidable obstacles to successful achievement of the goals of a babassu breeding program. The most obvious one is that of time. Breeding depends upon controlled pollination and testing of a range of potential combinations during what may be several plant generations. The breeding programs through which the African palm was developed from its native stands in the forests of West Africa involved from 38 to 48 years of trial and error to achieve an increase in yield from about three tons of fresh fruit bunches (FFB) to over 20 tons FFB per ha. in Malaysian plantations (Hardon, 1977; Hartley,

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[2] Anthony Anderson, personal communication.

[3] For example, in collections carried out from different populations of Orbicrnya in a five-state area of Brazil, the average proportion of fruit weight attributable to kernels was 8.7 percent, yet palms have been found with up to 17 percent of their weight in kernels. Similarly, fruit ranging in size from 4.4 cm. to 9.9 cm. in diameter and between 7.6 and 12.5 cm. in length have been encountered, while the range in fruit weight was from 80 grams to nearly one kg. It is just as likely that palms will be found that begin to produce fruit substantially earlier than the average of 10 to 12 years that maturation is estimated to require under optimal conditions today.

1970; Purseglove, 1972; Zeven, 1967).[4] Babassu, although exploited commercially for over 50 years, has never been subject to plantation trials, nor is there sufficient data on management of native stands to suggest the most appropriate measures for stand enrichment.

Although no one has measured maturation rates scientifically, Anderson (1983) estimates that babassu may require up to 70 years to mature under primary forest shade and competition. While nursery propagation and fertilized production in open plantations will undoubtedly reduce the maturation interval to a mere fraction of this time, it is questionable whether the institutional and economic conditions for long-term crop development research exists. Although crop development science in Brazil is relatively advanced, the nation can scarcely be expected to maintain a babassu breeding program for decades unless dramatic early results are obtained. There may be cause for hope that advances in tissue culture will enable rapid propagation of selected varieties of babassu that

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[4] Although plots of Elaeis were set out in Sumatra in 1859 (Purseglove, 1972), the first systematic breeding trials were only begun in 1915 (Hartley, 1970). Because the palms cross- pollinate, it is not possible to know the value of the parents until initiation of fruiting in their progeny. Selection requires a minimum time after planting of seven to nine years to obtain several years of fruiting records. In the trials begun in 1915, the first generation was selected from fruit taken six to 14 years after planting the first trial progeny; the second was selected between 11 and 17 years. Only at the end of the third cycle (also between 11 and 17 years) was the material considered of sufficient value for large-scale propagation. It was thus not until the early 1940s that substantial improved seed was available for plantation production, all probably originating from one palm planted near Bogor, Indonesia in 1848, nearly a century earlier.

could then be immediately distributed for stand enrichment, as an intermediate phase (Roca, 1983).

Even if the time problem could be solved with the aid of modern biotechnology, significant questions remain regarding the socio-economic implications of babassu as a plantation crop. It is extremely unlikely that ranchers in the Cocais, for example, where babassu is by far the dominant component of the vegetation, could be convinced to cultivate a plant which many of them regard as a nuisance. In extractive economies based on other trees, it is rare that landowners would allocate resources to plant a species for which they may have to wait many years for maturation when mature trees are abundant near at hand.

To assess the economic viability of plantation production of babassu at this juncture is exceedingly premature. However, a simple comparison of scenarios for stand enrichment using improved varieties with that of managing native stands can roughly demonstrate the temporal considerations noted above. In the simplified discounted cash flow analysis presented in Table 9.1., I assume that a native stand consisting entirely of mature palms managed over pasture produces two tons of babassu fruit per ha. at the base year. Juvenile palms are assumed to be cut back completely, so no new palms will emerge. Each year, the stand degrades with senescence by two percent of its original productivity, so that at the end of a 50-year period, fruit output will have ceased.

In the stand enrichment case, productivity also begins at two tons per ha., and is gradually enriched by planting improved varieties assumed to begin fruiting in the tenth year after establishment.[5] For 10 years after the base year, 10 percent of the original native stand is replaced annually by improved palms at a cost of $10 per year so that 20 years after planting the first palms, a productivity of 10 tons per ha. is achieved. The net value of babassu fruit at the farmgate is assumed for analytical purposes to be US$ 25 per ton (a figure which the firm CIT proposes to use for its planned upgraded operation). Cash flows are compared over a 25 year period (corresponding to one human generation), and are discounted to present value at a rate of 6 percent per year, chosen to reflect the long-term gestation of the resource in question. It is assumed for all alternatives that the output of potential crop or animal combinations with the palms would be equivalent; thus the analysis refers to partial budgets for the babassu enterprise alone.

At a discount rate of six percent, well below the real commercial rate of interest for unsubsidized agricultural investment in Brazil, the results of the analysis in Table 9.1. suggest that a landowner whose time horizon is 25 years would be financially better off if he were to enrich his babassu stand with improved palms. The net present value of the discounted cash flows for the enrichment case is nearly

[5] This time period was selected as an optimistic assumption, based on the information provided by farmers in the babassu zone.

Table 9.1. Hypothetical cash flow analysis for babassu palms over pasture. Babassu fruit assumed to fetch US$ 25 per ton at the farm gate.

YEAR	OUTPUT PER HA. (kg.)			NET VALUE (US$ per ha.)			CUMULATIVE VALUE (US$)		
	Base Case[a]	Enrichment[b]	Plantation[c]	Base Case	Enrichment	Plantation	Base Case	Enrichment	Plantation
0	2,000	2,000	0	$50	$40	($200)	$50	$40	($200)
1	1,960	1,800	0	$49	$35	$0	$99	$75	($200)
2	1,920	1,600	0	$48	$30	$0	$147	$105	($200)
3	1,880	1,400	0	$47	$25	$0	$194	$130	($200)
4	1,840	1,200	0	$46	$20	$0	$240	$150	($200)
5	1,800	1,000	0	$45	$15	$0	$285	$165	($200)
6	1,760	800	0	$44	$10	$0	$329	$175	($200)
7	1,720	600	0	$43	$5	$0	$372	$180	($200)
8	1,680	400	0	$42	$0	$0	$414	$180	($200)
9	1,640	200	0	$41	($5)	$0	$455	$175	($200)
10	1,600	1,000	10,000	$40	$25	$250	$495	$200	$50
11	1,560	2,000	10,000	$39	$50	$250	$534	$250	$300
12	1,520	3,000	10,000	$38	$75	$250	$572	$325	$550
13	1,480	4,000	10,000	$37	$100	$250	$609	$425	$800
14	1,440	5,000	10,000	$36	$125	$250	$645	$550	$1,050
15	1,400	6,000	10,000	$35	$150	$250	$680	$700	$1,300
16	1,360	7,000	10,000	$34	$175	$250	$714	$875	$1,550
17	1,320	8,000	10,000	$33	$200	$250	$747	$1,075	$1,800
18	1,280	9,000	10,000	$32	$225	$250	$779	$1,300	$2,050
19	1,240	10,000	10,000	$31	$250	$250	$810	$1,550	$2,300
20	1,200	10,000	10,000	$30	$250	$250	$840	$1,800	$2,550
21	1,160	10,000	10,000	$29	$250	$250	$869	$2,050	$2,800
22	1,120	10,000	10,000	$28	$250	$250	$897	$2,300	$3,050
23	1,080	10,000	10,000	$27	$250	$250	$924	$2,550	$3,300
24	1,040	10,000	10,000	$26	$250	$250	$950	$2,800	$3,550
25	1,000	10,000	10,000	$25	$250	$250	$975	$3,050	$3,800

Table 9.1., continued: Footnotes

[a] Base case is a native stand managed over pastures. Productivity declines at two percent per year due to senescence.

[b] Enrichment case assumes initial yield equivalent to base case. Each year, 10 percent of trees are replaced by improved babassu palms, which begin to produce at the end of the tenth year after planting, producing 10 tons per ha. when all are mature (in twentieth year). Planting costs $10/yr.

[c] Plantation case assumes all native palms replaced with seedlings of improved palms which begin producing 10 tons/ha. in tenth year. Clearing and planting cost $200 in year zero.

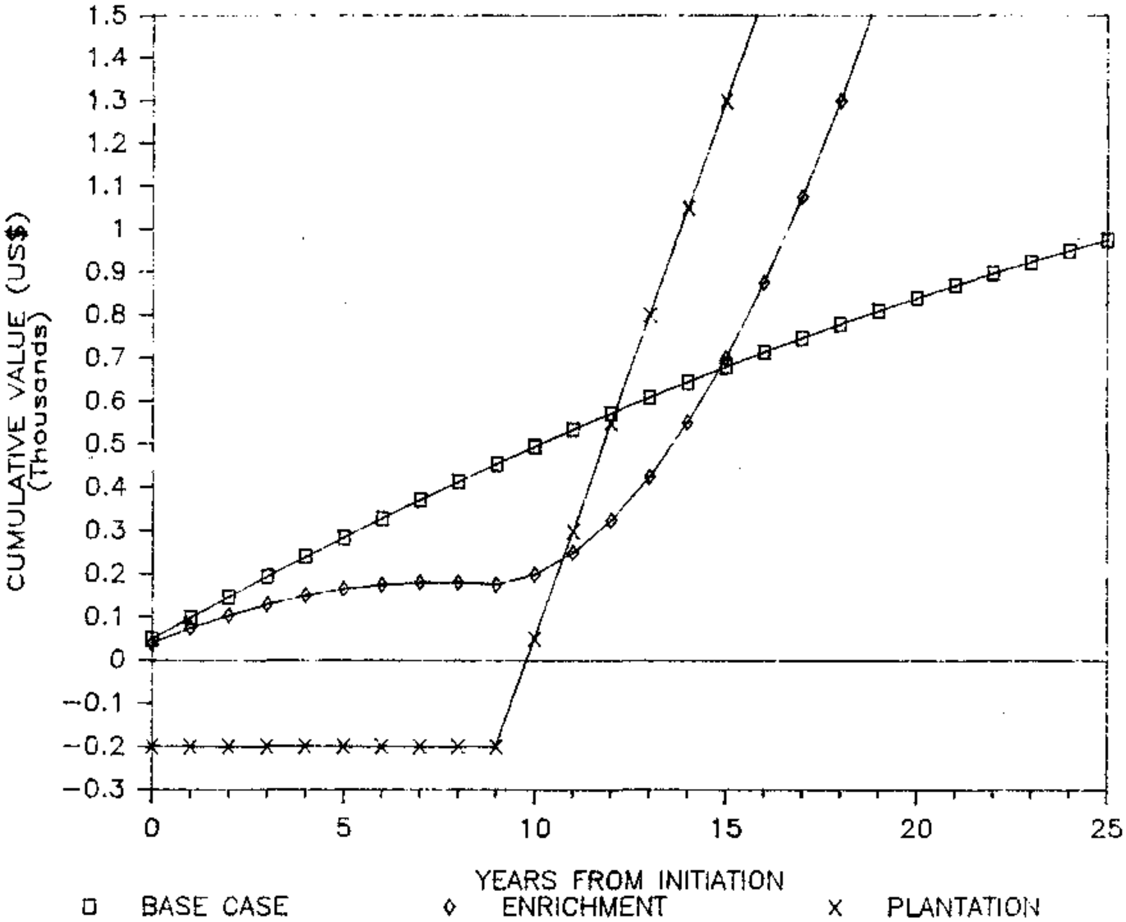

Figure 9.2. Cumulative net benefits from managed native stand and stand enriched by genetically-improved babassu palms.

double that of the base case for the managed palm stand subject to gradual degradation through senescence. However, Figure 9.2. shows that the cumulative net benefit derived from the base case is preferable to the enrichment case for 15 out of the 25 years. Only when nearly all improved palms have begun to produce does the enrichment case dominate, even assuming gradual diminishment in palm productivity from the base year. For a rancher concerned with maintaining stable cash flows throughout his time horizon, even a subsidized investment in babassu enrichment would be suspect. It is particularly questionable whether landowners in the babassu zone would carry out an enrichment program, given the limited knowledge of babassu palm selection and stand management methods, as well as the shaky condition of the kernel oil industry and the incipient nature of demand for whole fruit.

If the enrichment case is suspect, that of establishing babassu plantations in areas where native stands do not occur may be even more difficult to propose as a policy option. To compare this case, let us assume that a one ha. tract of good quality forestland is cleared in the base year, using manual labor, at a cost of $100. By the end of the same year, the entire tract is planted in improved palms whose establishment cost is an additional $100. For the next ten years, it is conservatively assumed that there is zero net cash flow to the enterprise, despite the opportunity costs of withholding this land from production of other than noncompetitive palm intercrops.[6] At the end of the 10-year growth cycle, all palms are assumed to commence fruiting, bearing 10 tons per ha. The value of the output is kept at $25 per ton, and discounted to the present at six percent. Despite the initial outlay and land rents foregone during the first 10 years, the plantation case slightly overshadows the enrichment case at this low discount rate. The sensitivity of this type of investment to higher interest rates is considerable, however. At an interest rate slightly under 10 percent, the enrichment case dominates that of plantation production.

The relative desirability of the plantation case is also sensitive to variations in parameters such as product prices, age of palms at maturation, and expected yield. Table 9.2 shows the sensitivity of an investment in babassu planting to variations in these parameters. If, to reflect the uncertainty of future revenues from babassu products, a price of $15 per ton is used, for example, there is a decline in present value for all options considered. On the other hand, if it is optimistically assumed that demand for babassu products will push prices up to $35 per ton, there will be a relative improvement in net present value across the board. The plantation case is more sensitive than either the base case or the enrichment case to variations in age at maturation or yield rates, however. If we project that, with genetic modification to increase palm precocity, age at first fruiting

[6] That is, the land could not be used for mechanized crop production and, in early years, cattle raising would not be possible due to potential damage to the palm seedlings.

Table 9.2. Sensitivity of babassu palm stand alternatives to interest rate, age at fruiting, yield, and price.

VARIABLE AND CASE	NET PRESENT VALUE IN US $			
	Interest Rate			
	0	**6%**	**12%**	**18%**
PRICE[a]				
$15 per ton				
Base case	585	336	229	174
Enrichment	1890	712	334	195
Plantation	2200	697	177	(-) 25
$25 per ton				
Base case	975	560	381	290
Enrichment	3080	1135	517	292
Plantation	3800	1295	429	91
$35 per ton				
Base case	1365	785	534	406
Enrichment	4410	1661	778	454
Plantation	5400	1894	680	207
YIELD AT MATURITY[b]				
5 tons per ha.				
Enrichment	1613	632	316	199
Plantation	1800	545	114	(-) 55
15 tons per ha.				
Enrichment	4488	1585	669	343
Plantation	5800	2043	743	236
AGE AT MATURITY[c]				
6 years				
Enrichment	4050	1613	765	427
Plantation	4800	1943	860	385
14 years				
Enrichment	2050	708	319	191
Plantation	2800	783	155	(-) 61

[a] Yield = 10 tons/ha.; age at maturity = 10 yr.

[b] Price = $25/ton; age at maturity = 10 yr.

[c] Price = $25/ton; yield = 10 tons/ha.

down to six years, the plantation case clearly overshadows the enrichment case, even at higher interest rates, and begins to look like a more attractive investment. Finally, yield rates lower than 10 tons per ha. of mature palms have an effect similar to that of price reductions in making plantation production relatively less desirable, while superior yields have opposite effects.

For Brazilian producers who face volatile markets for their crops, a crisis-laden domestic economy, and unstable climatic conditions in some areas, an investment which will show no net returns over existing practices for more than 10 years is very unlikely to be adopted. Where potential land rents are not as important as speculative gains, sinking capital into risky plantings, even if carried out at zero real cost to the investor, do not appear attractive enterprises.

In addition to somewhat shaky benefits on efficiency grounds, a plantation approach may not be beneficial from an equity perspective either. As Norgaard (1981) suggests, a rural development strategy based upon rationalized production of tropical perennial crops implies the need for well-organized systems for credit, marketing, storage, and transportation, as well as a supply of wage foods to make up for displaced staple crops. The capacity for organizing what amounts to a total agribusiness system is rarely affordable to peasants. The Brazilian government has preferred to focus credit on large corporations rather than nurture cooperative enterprise. A shift from extractive production from native palm stands to rationalized production of improved species presupposes further alterations in peasants' status. Plantation society has historically brought about a persistence of misery rather than a way for rural people to escape the vicious cycle of poverty (Beckford, 1972).

There are good reasons for skepticism regarding babassu's potential or desirability for crop development under classic plantation organization. Although its prospects for genetic improvement are good, babassu is unlikely to compete with already established intensive crops such as African palm or soybeans as a source of vegetable oil or fast-growing timber species for fuel. The advantage of babassu lies not in its potential to out-produce already established crops, but in its capacity to provide a wide variety of products useful in both market and subsistence economies without requiring heavy investment in crop development or plantation establishment.

While plantation production of babassu would doubtless generate more of the materials used by the peasantry such as leaves, palm heart, and fruit, the aims of plantation culture would run counter to the subsistence complementarity of native stand extractivism. Prohibitions against activities such as leaf harvesting or burning would be necessary to achieve optimal fruit yields. Intensive cultivation of babassu would therefore run against the grain of the palm's fundamental beneficial attributes. Monospecific stands of babassu form spontaneously under a wide range of soil fertility and moisture conditions, require little maintenance, and are used by people. Rather than introducing babassu into intensive forms of agriculture, the palms seem most amenable in their present form: as part of extensive systems of land use such as shifting cultivation and grazing (Anderson & Anderson, 1985).

Agroforestry systems throughout the world are considered to offer greatest potential for recuperation of degraded or fragile soils that are marginal for intensive agriculture (King and Chandler, 1978), and it is on such sites that the future of babassu appears to be most promising. The palm's unique ecological characteristics could make it promising for reforestation of excessively dry or nutrient-poor sites in areas where existing stands are being fully exploited, such as the dry cerrado. Babassu's adaptability to such sites could be enhanced by utilizing hybrids that appear to result from natural crosses with closely related palms such as piassava (*Orbignya eichleri*) and inaja (*Maximiliana maripa*). Existing genetic diversity can be tapped for a breeding program that could bear fruit in a reasonable length of time, by using progeny of precocious palms found in the wild that are adaptive to marginal growing conditions. Babassu could be intentionally established over extensive areas with minimal effort given its extraordinary capacity to dominate landscapes. Stands of the palm could then furnish both market and subsistence products while providing the permanent forest cover that is essential for maintaining long-term resource productivity.

The question remains, however, whether a society geared toward achieving optimum returns from resource investment is likely to settle for what appears a second-best alternative. A proposal to invest resources in a crop development program for babassu aimed at using marginal lands for extensive production by peasants is not likely to gain adherents. The same resources might go far toward developing a new crop for intensive cultivation and agro-industrial development for the benefit of elites. Clearly, the end goals of resource investment will play a major role in directing the aims of crop improvement.

Appropriate Industrial Technology Options

Similar to the option of intensive plantation crop development for babassu, the concept of large-scale whole fruit processing appears objectionable for social equity reasons. Instead of focusing government support for engineering research and credits' for pilot projects on centralized processing units, the option of farm or community-level processing might be considered. There are several alternative in this realm which, analysts have argued, promise to avoid the potentially devastating employment and income displacements associated with a centralized whole fruit processing approach. These include: (1) manual kernel extraction and on-farm carbonization of husks; (2) mechanical fruit peeling to generate feedmeal and ease manual breaking; and (3) downward-scaling of whole fruit processing technology (PSQ[7]) for portable or fixed farm or community-level enterprise.

The organization of local fruit collection centers involving manual fruit breaking by women and charcoal production from the husks is already an emerging form of production organization in parts of the babassu zone where whole fruit purchasing has been initiated (Chapter VIII). While the production relations which have emerged for local babassu cottage industries provide somewhat lower returns to the women involved, their employment in manual breaking and charcoal production allows for some complementarity in household labor allocation, which would not be the case if a whole fruit industry were to dominate the scene. It is notable that a U.S.-financed community development project has recently been initiated in one municipio on the Parnaiba River in Piaui geared toward manual babassu fruit breaking and testing of improved charcoal kiln technology developed by the CETEC research institute in Minas Gerais. Project objectives "seek to prove the feasibility of babaçu charcoal production as a community enterprise compatible with the attainment of other community goals" (Inter-American Foundation, 1984).

The collection center approach offers only partial realization of the additional benefits to be derived through a more complete separation of fruit fractions. As described in

[7] Following the convention used in Chapter VIII, the acronym "PSQ" is used here in reference to the peeling, separating, breaking technology developed for babassu fruit industrialization.

Chapter V, many babassu producers use babassu husks to fatten pigs and fowl which feed on the dry mesocarp during the period husks remain in storage before charcoal production. Mechanical removal of the outer layers would enable a more complete utilization of mesocarp meal as feed, and also reportedly facilitates manual kernel extraction.[8] A simplified dehusking apparatus would appear a fairly simple adaptation of the first stage of currently available PSQ technology. Such equipment could be mounted on trucks and transported to production centers by agricultural mechanization service (CIMEC) agents, charging a fee for the service.

Alternatively, a landowner having substantial feed requirements or a group of producers could install such equipment at the farm level. The fundamental simplicity of the dehusking apparatus suggests that a small-scale machine could be developed and made available at low cost. As many landowners in isolated areas have invested in rice hullers, cassava graters, forage choppers, and sugarcane crushers, small-scale processing of yet another of their basic products would not present major obstacles to adoption. There would need to be adequate demonstration of the benefits derived from increased kernel extraction and feed resources for this option to achieve broad dissemination.

The final option refers to alternatives that would involve full mechanization of fruit processing using PSQ technology scaled for portability or local installation. Such

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[8] Mariano Mendes, personal communication.

technology would essentially do the same thing as the centralized firms propose by separating all fruit fractions from one another for further processing, into oil, feedcake and meal, and charcoal. In the first instance, as in the dehusking venture described above, PSQ equipment would be transported to the collection locale and all fractions separated on site, where they could be stored and processed locally or brought to other units elsewhere that would process them centrally, such as the IPT carbonization unit in Teresina, Piaui.

Finally, a similar system could be installed at the local level, assuming sufficient raw material were available to warrant the expense. Such a scheme was the goal of the State Institute of Babassu in Maranhão, which had begun negotiations for initiation of a long-term research and development project with technical support from the German Appropriate Technology Exchange.[9] This locally-based processing scheme was preferable to the oil industrialists of Maranhão, who sensed that a large-scale whole fruit processing industry would mean their firms' "creative destruction," as suggested in Chapter VIII. An alliance with their suppliers among the landed aristocracy to extract kernels mechanically at the farm level could fortify the babassu oil extractors, enhancing their chances for survival if output could be increased at low cost.

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[9] This project, originally planned to begin in 1985, was delayed due to elimination of the State Babassu Institute. It is currently being renegotiated for execution in collaboration with the State Agricultural Research Corporation of Maranhão (EMAPA), according to recent information (Anthony Anderson, personal communication).

Landowners with whom I discussed the farm-level processing option were generally interested in the possibility of obtaining such a machine, so long as the products it generated would increase their returns from babassu. At the same time, they felt that they would restructure the way they organize babassu- related activities, were they to adopt whole fruit processing technology. The share of the returns that would flow to them versus their resident workers would be altered in their favor.

The appropriateness of an alternative industrialization scheme is ultimately dependent upon the degree of control exercised by the producer over the outcome of his or her labor. Whole babassu fruit processing at the local level might be only slightly less labor-displacing than one established at a central location. The difference would come from the disposition of the rewards from adopting the innovative technology. Reacting to German technical assistance representatives' concerns for peasant welfare, Brazilian officials said that anticipated social impacts from babassu technology development would not be considered grounds for property rights reform in the babassu zone.[10] As the efforts to initiate a farm-level babassu processing project in Maranhão suggest, landowners would derive the principal benefits, while a level of labor displacement of similar magnitude to that of a centralized PSQ industry might be the result. Even though

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[10] **This was the position of a high-ranking official in the state cabinet, expressed at a meeting I attended in Maranhão.**

the alternative babassu fruit processing options described above would have lesser employment impact, their relative benefit to the peasantry depends on how well the returns from more integral use of palm products are distributed.

Conclusions

This chapter has reviewed a range of scenarios under which a whole babassu fruit processing industry might develop, to assess which factors will most determine the impacts resulting from industrial innovation. In areas, such as the cerrado of Maranhão, where nearly all babassu production is currently being harvested, a shift toward whole fruit processing is expected to result in severe employment displacement. This is particularly true where, as in the areas around Caxias, Maranhão, land use is being transformed with development of sugarcane and cellulose agro-industries.

In contrast, in areas not currently subject to babassu extraction pressure, such as the Baixada and cocais regions, there is potential for greater utilization of existing stands. In the Baixada case, where agro-pastoral development pressure is not intense, introduction of the new industry could lead to both efficient and equitable results. In the cocais and western frontier of Maranhão, on the other hand, land is already experiencing severe competition. While the palms are currently underexploited, this is probably due more to the delimitation of stands and expulsion of peasants than to rational decision-making by peasants. The development of a whole fruit processing enterprise in the latter areas is perceived as desirable by investors, given the underexploited status of the resource. However, there may be some problems in securing seasonal labor in rural areas due to the ongoing expulsion of peasants. Furthermore, the continuing suppression of juvenile palms in pastures promises to result in long-term degradation of babassu stands.

In answer to the stand degradation problem, as well as to the low productivity of native babassu palm stands, researchers are currently investigating the potential for genetic improvement in babassu. While technically promising, temporal considerations suggest that palm stand enrichment may not be attractive to farmers when compared with exploitation of existing stands. Development of babassu plantations in areas where there are already significant underexploited native stands also appears unjustifiable. If efforts are to be made toward crop development with babassu, they should focus on the palm's unique attributes as a providor of a variety of useful products under extensive land uses such as grazing and shifting cultivation. Palms adapted to marginal lands could enable reforestation of degraded sites, and help to support small farm production in areas currently lacking in extractive resources.

Finally, I examined several alternative approaches toward technical innovation in babassu processing, to determine whether their adoption might alleviate the severe employment displacement expected from a centralized industry. It appears that any alternative which involves mechanical fruit breaking will displace labor. If a share of the benefits from a fuller utilization of babassu is not distributed to those who suffer from change, appropriate technologies only act as palliatives. The only way to ensure that benefits reach those who now depend on babassu requires that their property rights to the palms be legitimized. The concluding chapter addresses the issues of land and market reform in the babassu zone, and suggests lines for policy aimed at achieving a just solution.

CHAPTER X

CONCLUSIONS AND POLICY RECOMMENDATIONS

Babassu palms constitute an important natural resource that provides both cash and subsistence benefits to over 300,000 peasant households in the state of Maranhão in the Mid-North region of Brazil. Babassu also generates value-added to the regional economy through a vegetable oil and by-products industry. Property rights under traditional production systems in the babassu zone represent a combination of private and common use. Access to land for shifting cultivation and palms for extractivism is provided by land-owners under informal contracts permitting peasants to reside on their properties in exchange for in-kind rents and a stable labor supply. Within the realm of such estates, as well as on small owner-occupied properties and unclaimed state lands at the Amazon frontier, peasants collectively manage subsistence resources. Babassu palms are managed within shifting cultivation and livestock enterprises to provide sustained yields of goods and environmental services. A complex of rights and responsibilities for resource use and protection is built into tenancy contracts and community property governance.

This thesis ends where it began, with the problem of property rights as the dominant factor determining how the rewards from agro-industrial innovation are partitioned. As rights to use of essential subsistence resources are curtailed in the babassu zone, property rights institutions that have enabled people to manage those resources for sustained yield have faltered. Where common management of babassu palms and similar natural resources prevailed in the past, pressures for commercialization or subsistence demands have subjected these resources to rates of depletion as severe as those to be anticipated under open access conditions. By denying access to resources, pasture expansion has been the primary cause of these pressures. Development of an industry enabling full utilization of babassu fruit will place further burdens on resources remaining to those of the peasantry excluded from the benefits of technical innovation. The result from both processes is a tragedy of the non-commons.[1]

Technical fixes, such as the genetic improvement of palms suitable for recuperation of marginal land or the appropriate scaling of processing technology, are only partial solutions to a non-commons tragedy. Development economists have been roundly criticized by Hirschman (1981:23) for seeking partial solutions to complex problems:

> They thought it legitimate to operate on the basis of an implicit Pareto-optimality assumption: like plumbing repairs or improvement in traffic control, the technical efforts of economists would improve matters in one area while at worst leaving others unchanged, thus making society as a whole better off. . . Development economics could carry on regardless of political cataclysms.

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[1] The benefits to society and specific actors from both pasture establishment and a whole fruit processing industry are contrasted with their corresponding costs in Table 10.1.

Table 10.1. Assessment of social costs and benefits of whole fruit processing and agro-pastoral expansion.

BENEFITS	COSTS
INCREASE INDUSTRIAL UTILIZATION OF OTHERWISE "WASTED" FRUIT BY-PRODUCTS	LIMIT UTILIZATION OF FRUIT BY-PRODUCTS BY PEASANTS
° Reduce need for imported industrial fuels and extra-regional raw materials	° Intensify pressure on extractive fuels; necessitate purchase of commercial fuels
INCREASE EFFICIENCY OF BABASSU FRUIT PRODUCT EXTRACTION USING MECHANICAL PROCESSES	REDUCE RURAL EMPLOYMENT BY UP TO 90% PER VOLUME OF FRUIT PROCESSED[a]
° Increase value of babassu fruit, raising landowners' revenues and workers' wages	° Reduce consumption multiplier effect of peasant trade of kernels for commercial goods
° Motivate retention of palms over pasture in development projects as a beneficial silvi-pastoral system	° Reduce complementary use of women and children's labor in household income generation
° Ensure more stable and less costly supply of lauric oil and feedcake	° Restrict access to pasture stands of babassu to piecework gatherers
MAKE MORE EFFICIENT AND CONTINUOUS USE OF LAND FOR PERMANENT PASTURES AND MECHANIZED CROPS	REDUCE ACCESS TO LAND FOR SHIFTING CULTIVATION AND USUFRUCT TO BABASSU PALMS
° Increase revenue to landowners	° Reduce wage foods production
° Contribute to national trade balance	° Lose value-added to regional economy if goods are exported unprocessed
° Enable oil industry to operate year-round with other oilseeds than babassu	° Degrade resources due to pressures on land and palm stands that remain

[a] Based on analysis in Mattar (1979), described in Chapter VIII.

Pareto-optimality is suspect as a criterion for evaluating development processes leading to property rights restrictions. The ability of gainers to compensate losers is in no sense sufficient to ensure that the ex post income distribution will resemble that ex ante. In fact, debate on the issue concluded that Pareto-optimal solutions are reached solely under the condition that gainers are not only able to compensate the losers, but indeed do so (Kaldor, 1939; Hicks, 1939). Where the losers are members of a large group of fragmented, powerless and, for the most part, landless peasants, even the placement of full liability on the gainers to compensate the losers will not yield an efficient, much less equitable solution.

Under circumstances where market failure results in a worsening of inequities as well as unsustainable exploitation of natural resources, public policy adjustments may yield partial solutions. A recent economic analysis of policy measures to encourage agricultural output growth while also improving per-capita incomes in Northeast Brazil found that the only significantly effective route to this end is one of land reform (Kutcher & Scandizzo, 1981).

While the legal and institutional framework for expropriation and redistribution of inefficiently utilized rural land has existed in Brazil since 1964,[2] achievements of the

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[2] Law number 4504 of the 30th of November, 1964, entitled the "Estatuto da Terra" established the framework for titling of occupied land, expropriation and indemnization of latifundia, distribution of land to small farmers, colonization, commercialization, and support prices.

land reform program have been insignificant to date (World Bank, 1983b). Up to the 1970s, Brazilian agricultural output growth was accommodated principally by frontier expansion. Since then, policy has supported intensification of existing agricultural land use, emphasizing transformation of latifundia to "junker" style mechanized estates, together with conversion of the formerly resident laborforce to a free rural proletariat (Goodman, 1984). This historical process enabled the agrarian aristocracy to avert a loss in territorial and therefore political assets, which may have been the underlying objective of the 1964 land reform statute.[3]

The civilian administration which took power in March, 1985 has emphasized land reform and removal of agricultural price controls as the linchpins of its rural development policy. The new government's political coalition, an important part of which lies among the landed elite of the Northeast, was not expected to accomplish a sweeping property distribution due to intense pressure from landed interests (Simons, 1985). In fact, the agrarian reform decree which was signed into law in mid-October, 1985, while promising to find land for 1.4 million landless households in the ensuing four years, provides no clear indication of who will have to forfeit land for redistribution. Only lands not under production are to be treated as expropriable, but the meaning

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[3] Goodman (1984) cites government planning documents of the 1960s period which express concern that national industrial development would be blocked by "archaic" rural social structures that would create bottlenecks in urban wage food supply and stimulate inflation.

of "under production" is not spelled out.[4] If land is in fact expropriated, it is likely to be that on the least productive soils, reducing the opportunity for output gains and making it difficult for peasants to develop viable farms.

Efforts to promote small farm productivity growth in Northeast Brazil over the past decade have had mixed results. While research and observation point to vastly superior productivity on small farm properties over that on latifundia (Kutcher and Scandizzo, 1981), regularization of property rights has been exceedingly limited to date (World Bank, 1983a), and promises to remain so unless peasants can be effectively mobilized to force a reticent administration to comply with its own decree. One analysis suggests that a full redistribution of land would be neither feasible politically nor beneficial economically to the landless, who would lose complementary off-farm income if large properties were redistributed (Bastos, 1980). This analysis was based on assumptions that fixed technology and price margins would eliminate the chance for realizing a net gain in farm income. However, such an approach ignores the prospect that small farmers could organize collective production and marketing tactics to reduce costs and share risks. Land reform as an isolated policy is not a panacea.

The tragedy of the non-commons must be perceived as one having essentially political-economic rather than purely

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[4] Decreto no. 91.766, signed by President José Sarney on October 10, 1985, "approves the national agrarian reform plan;" Diário Oficial, Oct. 11, 1985.

technical solutions. Three basic approaches may be taken toward political claim-making: imposition of state regulatory powers, advocacy by a disinterested actor, and moral movements. The failure of current regulatory approaches to halt babassu eradication or to protect peasants from dispossession has been described in Chapter VI. Recourse to advocacy by the Brazilian peasantry has been limited to efforts on the part of the Catholic church through the movement for base communities and Pastoral Land Commissions that serve as watchdogs against illegal speculation and violence. Peasant unions have begun to focus on the babassu problem as a rallying ground for organizing. The emphasis has primarily been upon the relations of production and marketing of babassu fruit and kernel. Rural workers from all over the babassu zone discussed common concerns at two regional conferences in 1982 and 1983. The proceedings show that peasants perceive the babassu problem as a key issue in rural employment and land disputes (CONTAG, 1982; 1983).

In the babassu case, technical innovation would be in the interest of both landowners and industrial innovators, but would exclude those of the peasantry who are most dependent on the palm for income. In order to alter this scenario to benefit the peasantry requires that those responsible for technology development perceive that the peasants, not those who hold title to land or control industrial capital, are their clients. This in turn necessitates that peasants secure a claim to native palm output either through legitimation of traditional usufruct, or through distribution of the resources themselves to those who use them.

The control over property rights also affects the scale and capital intensity of the industry. The relative surplus of labor in the babassu zone would tend to favor more labor-intensive solutions for industrial processing than those devised to date. Furthermore, the dispersed nature of the native babassu resource suggests that industrial processing viability will be obtained at smaller scales. Improving the returns to the peasantry from technical innovation would, however, require not only that they control the rights to the resource, but also that greater control or bargaining power with respect to product marketing and processing pass to them.

The elucidation of the prospects for accomplishing these ends demands further action-oriented research. The concluding section of this chapter suggests a strategy for research and development for the babassu sector aimed at achieving a more just distribution of the rewards from innovation.

Alternative Policies and a Development Strategy

Is there an alternative to the negative sum game in outcomes of resource investment? Must all resources be aggrandized to the benefit of a small group of powerful investors for economic development to be achieved? To change the rules of the game, the problem from a political perspective is one of empowering a large, "diffuse" group (Olson, 1964) — enabling peasants to impose sufficient pressure to bring about a desired change. Such empowerment and collective action can be achieved within a constitutional republic under the rule of law, or may require more tumultuous political and social reorganization to assure that peasant rights will be upheld.

Achievement of a property rights transfer legitimizing peasant access to resources is not likely under the current socio-political framework governing the babassu zone. Past experience suggests that just means for resolving rural problems will not be achieved quickly. However, the redemocratization of Brazilian society offers hope that decision-makers will begin to perceive that their political interests lie in lending support to peasant movements that have arisen. With this opening, new leaders may emerge, to assist in focusing rural activism on concrete demands.

The principal foci of organizing efforts to date have been those of resolving land disputes and ensuring adequate remuneration for rural workers. Titling of insecure occupants of rural lands and redistribution of idle resources to the landless are the highest priorities. They are receiving limited but real governmental response today. It is safe to say that little lasting benefit will be obtained from other policy actions without a commitment to agrarian reform. Yet, a focus solely on this issue, while necessary, is insufficient. There is a commensurate need to work slowly at the local level on the empowerment of rural communities so that broader policy changes can result in lasting improvement in peasant welfare.

Such an approach must count on the collaboration of a well-trained and committed cadre of development professionals willing to reside in rural areas and serve as channels for resources and technical information, as well as learn from the local population and reflect their needs to the broader society. Such a cadre already exists among the ranks of the Brazilian rural extension service, EMBRATER, whose local staff are the only government officials present in literally every rural county. They are typically responsible for a broad array of social and technical programs, from improved seed trials and home economics to emergency public works administration and biogas generation. They are understaffed and poorly equipped to take on new functions. Yet, I believe they represent the only public institution suitable for guiding the range of activities needed to achieve equitable rural development in the babassu zone.

In doing so, extensionists will be allied with the rural workers' unions as well as with the farmers' organizations which represent small- and medium-sized landowner interests. While their interests do not frequently coincide with those of the landless, the alienation of landowning farmers can do nothing but harm to efforts to resolve local problems. Small property-owners are in some cases just as reliant upon babassu as the landless. Resolution of local property issues should both ensure that small and medium-sized farms are not threatened with expropriation, and that the benefits of babassu industry development also flow to them. The question is, how can policy and local action ensure that the benefits of development are not aggrandized among the elite but, instead, become more fully shared among local inhabitants?

The key to successful distribution of the rewards from innovation lies in altering the prevailing institutional mechanisms through which benefits are partitioned. Both peasants and owners of stands must be perceived as the clients of new initiatives in babassu productivity enhancement or industrial technology development. This implies that both parties can benefit from increased revenues. Where the two interests do not coincide, existing legal instruments must be enforced to ensure compensation of those excluded from benefits due to the prevailing distribution of property rights, or limited employment opportunities.

If the peasant is defined as the "producer" of babassu, rather than the landowner or merchant, several opportunities arise. Under existing price floor policies, producers are entitled to pre-harvest financing of their output, which is retained as a buffer stock for disposition at the discretion of the responsible government agency (Commission for Production Financing - CFP). Such financing could eliminate reliance by peasants upon creditors for advances against future production, as well as enable them to better plan for their production needs since they would know the minimum value of their product in advance. In the case of babassu kernel, such a system could also help guard against seasonal price fluctuations, and would give oil extractors and buyers a more secure basis for managing raw material purchases.

Alternative rental agreements providing for long-term access and specifying rights and responsibilities for both babassu fruit collectors and stand owners would also reduce grounds for conflict and promote security of revenue. Such agreements could also serve to stimulate management of palm stands by renters since they would have a stake in greater output. Arrangements such as these could draw on institutional innovations already developed spontaneously by producers that provide peasants with rights to fruit in exchange for pasture weeding, as described in Chapter VI.

A share of increased babassu revenues could be diverted as transfers to compensate those excluded from direct benefits. Taxation on primary product marketing in Brazil includes a share of the value-added for general government revenues and a separate segment earmarked for the rural social security program (FUNRURAL). A small part of the proceeds from these taxes is distributed according to the origin of the products marketed, but most remains at the state and federal level rather than returning as resources for local investment. Tax revenues on babassu product marketing could be applied directly as transfers to those displaced by industrial or agro-pastoral development, or finance training of young adults for new rural employment opportunities arising from those developments (road construction, stand and nursery management, transport, and manufacturing skills). Alternatively, tax revenues derived from babassu marketing could be allotted for development of local health, extension, or other public service facilities.

A more direct mechanism for ensuring that rewards from resource development would have broad local benefit would be to establish babassu industries as community enterprises. The net returns from such enterprises could serve as the basis to leverage other funds for investments in local facilities. Such an approach has already been initiated in the state of Piaui, as described in Chapter IX, with seed money from the Inter-American Foundation. Local initiatives of this sort deserve a continuing commitment of public support so that they can be nurtured and improved.

As evidenced by the eradication of babassu stands and expulsion of peasants in areas of pasture expansion, government subsidies to support livestock improvement have had negative environmental, social, and economic consequences. Ranchers who benefited from such subsidies had little incentive to retain babassu palms over their pastures. There is even indication that government agronomists actively encouraged them to clearcut palms.

If the babassu-pasture system is to be desired over stand eradication, a research and development campaign is necessary to avoid that the mistakes of the past are not repeated. Such a campaign should proceed from the research effort already underway at regional agricultural stations, but requires a greater commitment of trained personnel and a closer link with extension education and policy making to bring it to fruition. The role for agro-pastoral subsidies would then be to encourage rather than constrain the range of alternative enterprises so as to include babassu stand retention, management, and enrichment as eligible investment costs to be shared by the public. One method to at least reduce the pressure for babassu deforestation would be to insist that lands with babassu palms be compulsorily included in the forest reserves required by law within development projects in Amazonia.

However, where investors benefit from public largess through subsidies, they should also be subjected to greater scrutiny regarding the outcome of the shared cost. The tax reinvestment schemes that finance regional development funds in Brazil are aimed at returning dividends to the firms which avert tax payments in this way. However, these funds in fact represent transfers of general federal revenues and should not promote regressive outcomes. A principal criterion for approval of subsidized projects should be that of employment generation, while recognizing that displacement of existing agricultural production and extractive activities represent opportunity costs.

In summary, the guiding principle for policy and local action in the babassu context should be that of determining how those excluded can be compensated. Local political organizing through the existing legal and institutional framework can ensure that liability for external costs is made specific and enforceable. Recognition of the peasant as the "producer" of babassu would enable establishment of buffer stocks and application of minimum pricing guarantees, as means to achieve both stability in raw material supply and secure producer revenues. Long-term contractual relationships for babassu harvesting can help to avert conflicts as well as ensure that stands are managed for improved productivity. Individual transfers or local facilities investments using tax revenues derived from marketing of babassu products would be appropriate mechanisms for compensation.

Research and development on appropriate stand management and industrial technology are valid objects for publicly subsidized investments. Allowing public funds to be used for continued eradication of babassu palms within agro-pastoral projects contradicts goals for sustainable development. Above all, decisive action in the babassu case requires that peasants as well as landowners be perceived as clients, and that property rights be treated as the critical factor defining the partitioning of rewards from agro-industrial change.

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APPENDIX A: FIELDWORK METHODS

A.1. Site Selection Procedures

The procedure I followed for selecting representative municipios is described in this appendix. First, I identified which of the babassu zone's 74 municipios fit into each of the three agro-ecological subregions described in Chapter III. To do this, I commissioned a map of the state containing the borders of the municipios at the same scale as those available for agro-ecological subregions and stand coverage rates. I then overlaid the three maps and identified 25 municipios, each of which lie entirely within one of the three sub-regions. Besides the rate of babassu stand coverage, the following indices were compared to establish representativity:

(1) economic importance of babassu (operationalized as the ratio of babassu kernel to rice output);

(2) rural population density (inhabitants per $km.^2$);

(3) intensity of livestock production (operationalized as number of head of cattle per $km.^2$);

(4) percent change in population from 1970 to 1980;

(5) average area in annual crops per agricultural establishment (average of 1975 and 1980 census figures);

(6) percentage of total area in farms under annual crops (average of 1975 and 1980);

(7) percentage of total area in rice produced as a monocrop in 1980;

(8) soil fertility (operationalized as average rice yield per unit land in 1980);

(9) degree of rigidity in property rights to land (operationalized as percentage of total farm area in hands of squatters in 1980);

(10) market accessibility (operationalized as km. of paved highways per $km.^2$).

Subregional mean values for each index were obtained for each of the 25 municipios lying wholly within the three agro-ecological zones, and the absolute value and percentage deviation from the mean taken. Those municipios having the lowest average percent deviation from the means across all indices, and the lowest sum of ranked deviations were selected as being most representative of regional characteristics.

A.2. Survey Instruments[1]

Baseline Survey

CENSO DE LOCALIDADE DE LEVANTAMENTO

INSTITUTO ESTADUAL DO BABAÇU - INEB
SECRETARIA DE AGRICULTURA DO MARANHÃO
ANALISE SOCIO-ECONOMICA DE SISTEMAS DE PRODUÇÃO AGRO FLORESTAIS DO BABAÇU

MUNICÍPIO ______
LOCALIDADE ______
Nº DO PRÉDIO (SUCAM) ______

NOME DO ENTREVISTADO ______
APELIDO ______

QUANTAS PESSOAS MORAM ATUALMENTE NESTA RESIDÊNCIA? (Nº PESSOAS)

2 QUAL A IDADE E O SEXO DE CADA PESSOA QUE MORA NA RESIDÊNCIA?

IDADE

SEXO M F | M F | M F | M F | M F | M F | M F | M F | M F | M F | M F

TOTAL MASCULINO
TOTAL FEMININO

3 QUAL O TRABALHO PRINCIPAL DOS RESIDENTES MAIORES DE 14 ANOS?

Nº DE PESSOAS M F
AGRICULTOR (A)
VAQUEIRO
QUEBRA CÔCO
COMERCIANTE

OUTRAS ATIVIDADES DOS RESIDENTES PARA GANHAR DINHEIRO OU OBTER BENS DE CONSUMO

______ ATIVIDADE ______ ATIVIDADE ______ ATIVIDADE ______ ATIVIDADE

4 TEM PARENTES NA MESMA LOCALIDADE OU PERTO DA RESIDÊNCIA? 1 - SIM 0 - NÃO

5 ESSES PARENTES COOPERAM OU CONTRIBUEM PARA AS NECESSIDADES DE VOCÊS? 1 - SIM 0 - NÃO

6 TEM PARENTES FORA DA LOCALIDADE QUE APOIAM A FAMÍLIA? 1 - SIM 0 - NÃO

7 DE ONDE SÃO OS RESIDENTES?

8 QUANTO TEMPO MORA NA LOCALIDADE?

9 QUANTAS VEZES MUDOU DE LUGAR DURANTE OS ÚLTIMOS CINCO (05) ANOS?

10. ESSA CASA E PROPRIA, ALUGADA, OU EMPRESTADA?

11 A CASA É DE QUE TIPO DE CONSTRUÇÃO?

12 QUANTOS QUARTOS A CASA TEM?

13 A FAMILIA TEM BODEGA COMERCIAL?

14 TEM TRANSPORTE PRÓPRIO?

15 SE A FAMÍLIA TEM GADO, QUANTAS CABEÇAS TEM?

16 QUAL A PROPRIEDADE DA TERRA EM QUE A FAMÍLIA PRODUZ NA LOCALIDADE?
QUANTOS HECTARES SÃO EM TOTAL?

17 SE PAGA RENDA, ALUGUEL PARA USAR ESSA TERRA, QUANTO PAGA?
O PROPRIETÁRIO EXIGIU PAGAMENTO DO ALUGUEL EM 1983?

18 ÁREA DA ROÇA EM QUE PRODUZ EM UM ANO REGULAR

19 EMPREGA PESSOAS FORA DA FAMÍLIA NA ROÇA?

20 TEM TERRAS FORA DA LOCALIDADE EM QUE MORA?

21. SE A FAMÍLIA TEM ACESSO PARA COLETA DO BABAÇU
QUE PRODUTO DO BABAÇU VENDE?

22 QUE PRODUTOS DO BABAÇU USA EM CASA?
PRODUTOS QUE SE FAZ EM CASA:

23 PARA QUEM VENDE AMENDOA DE BABAÇU?

24 ONDE QUEBRA CÔCO DO BABAÇU, NA MAIORIA?

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[1] While a variety of additional instruments were developed and applied at all phases of the fieldwork, I have only included those used for the baseline and weekly cost-route surveys of peasants and small farm households. Copies of the other instruments used are available.

Weekly Household Budget Questionnaire

LEVANTAMENTO SEMANAL
DE ORÇAMENTO FAMILIAR

MUNICÍPIO ____________
LOCALIDADE ____________
CHEFE DA FAMÍLIA ____________
DATA ___/___/___

FONTES DE RENDA E CONSUMO DIRETO

CÓDIGO	PRODUTO/ATIVIDADE	UNIDADE	VALOR/UNIDADE	QUANTIDADE CONSU	QUANTIDADE VENDIDA	QUANTIDADE TOTAL	VALOR TOTAL (C+[illegible])
01	FARINHA D'ÁGUA	kg					
02	FARINHA SECA	kg					
03	FEIJÃO	kg					
04	ARROZ	kg					
05	MILHO	kg					
06	BANANA	penca					
10	SUINO	kg					
11	CAPRINO/OVINO	kg					
12	GALINHA	gal.					
13	OVOS	ovos					
14	LEITE	litro					
20	PEIXE	[illegible]					
21	ANIMAL CAÇADO						
22	AMENDOA BABAÇU	kg					
23	CARVÃO BABAÇU	lata					
24	PALHA BABAÇU	palha					
25	COFO BABAÇU	cofo					
26	LENHA/CARVÃO						
27	OUTRO EXTRATIVO						
30	SERVIÇOS TERCEIROS	dias					
40	APOSENTADORIA	semanal					
50	ARTESANATO						
60	OUTRAS ATIVIDADES						

DESPESAS SEMANAIS

CÓDIGO	ITEM	UNIDADE	VALOR/UNIDADE	QUANTIDADE	VALOR TOTAL	CÓDIGO	ITEM	UNIDADES	VALOR/UNIDADE	QUANTIDADE	VALOR TOTAL
00	COMIDAS ETC					20	EM PRODUÇÃO				
01	ARROZ	kg				21	HERBICIDAS				
02	FEIJÃO	kg				22	PESTICIDAS				
03	FARINHA	kg				23	FERRAMENTAS				
04	AÇUCAR	kg				24	SEMENTES				
05	SAL	kg				25	SERVIÇO DE TERCEIRO	dias			
06	LEITE EM PÓ	lata				26	FORO/ABRADO				
07	SARDINHA	lata				27					
08	ÓLEO	lata				27					
09	CAFÉ	kg				27					
10	CARNE	kg				27					
11	CACHAÇA	litro				30	TRANSPORTE				
12	FÓSFORO	caixa				31	PARTE, MANUTENÇÃO				
13	QUEROSENE	litro				32	SERVIÇO ALHEIA				
14	FUMO/CIGARRO	pacote				33					
15	SABÃO	barra				40	REMÉDIOS				
16	CARVÃO	lata				41					
17	MACARRÃO					42					
18	LEGUMES					50	ROUPA				
19	PEIXE					51					
19	BOMBRIL					60	OUTRAS				
						61					
						61					

Household Recording Form for Babassu Production and Use

PRODUÇÃO E DISPOSIÇÃO DIÁRIA
DE PRODUÇÃO DO BABAÇÚ

INSTITUTO ESTADUAL DO BABAÇU - INEB
SECRETARIA DE AGRICULTURA DO MARANHÃO
ANÁLISE SÓCIO-ECONÔMICA DE SISTEMAS DE PRODUÇÃO
AGROFLORESTAIS DO BABAÇU NO MARANHÃO

MUNICIPIO [illegible]
LOCALIDADE [illegible]
CHEFE DA FAMÍLIA [illegible]
DATA 01 /06 ___ /___

PRODUTOS / DIA/PRODUÇÃO	VENDA DA AMENDOA	CONSUMO LEITE COCO	CONSUMO AZEITE COCO	VENDA DE CARVÃO	CONSUMO DE CARVÃO	PRODUÇÃO DE COFO	PRODUÇÃO DE PALHA DE COCO
DOMINGO							
SEGUNDA FEIRA	10 K	3 K	[illegible] K				
TERÇA FEIRA	2 K	2 K					[illegible]
QUARTA FEIRA	3 K	1 K					
QUINTA FEIRA	1 K	1 K	3 K				
SEXTA FEIRA	2 K	1 K					
SABADO							
TOTAL							

APPENDIX B: CONCEPTUAL MODEL OF PALM-PASTURE PRODUCTIVITY

In this appendix, I define a hypothetical model simulating babassu-pasture interactions as a basis for further bioeconomic research.

Despite the potential productivity benefits of the babassu-pasture combination for livestock and pasture vigor described in Chapter VI, at some level of palm density, shading will reduce pasture grass dry matter production and hence liveweight gains in cattle. Research on managed pastures under coconuts suggests that light transmission rates range "from 5 percent to 97 percent depending on the density, height, age and canopy characteristics of palms" (Reynolds, 1980:41). Some pasture grasses perform better than others at increased shading levels. Jaraguá, the preferred pasture grass in the babassu zone, has not been subject to studies of carrying capacity change under increased shading. However, most tropical grasses are intolerant of light transmission values less than 40 percent (Reynolds, 1980). In coconut plantations, light transmission increases with the height of the palms, so that pastures established under mature palms can be anticipated to be less affected by shade than those under immature stands (Litscher & Whiteman, 1982).

The model developed in this appendix incorporates native babassu palms at different densities, assuming a quadratic functional response in fruit yield with maximum output at densities ranging between 100 and 150 adult palms per ha. As a simplifying assumption, the model does not include young unproductive palms. Instead, it is assumed that the stand is of uniform age and that all palms are potentially productive.[2] As palm density increases, spacing between leaf crowns decreases, and light transmission is assumed to decline linearly. Leaf crowns are assumed to intersect at stem distances under 7.5 m.,[3] beyond which point shade would be evenly distributed and increasingly heavy. The model further assumes that light transmission is zero at the palm density where crowns intersect, creating a closed canopy.[4] This density is at most 205 palms per ha. under triangular spacing.[5] Thus, the relation between palm density and light transmission is:

$$L_D = 100 - 0.59D \qquad (1)$$

where L_D = light transmission at density D (in percent), and

D = palm density in number of mature palms per ha.

---

[2] This assumption resembles reality in that management of palm stands usually involves elimination of unproductive older palms or machos. Most stands are formed simultaneously by clearing for shifting cultivation, so that they consist in general of uniformly aged palms.

[3] Babassu leaves are inclined to the stem at angles less than 60° and average 7.5 m. in length. Average crown diameter at a leaf inclination of 60° would therefore be 7.5 m.

[4] This is a conservative assumption, since palm leaves are angled perpendicularly to the ground, and because light penetration increases as the height of the canopy grows taller with maturity.

[5] See footnote four in Chapter VI for an explanation of this calculation.

Cattle stocking rates are assumed to affect liveweight gains per unit land according to a symmetrical quadratic function.[6] Pasture composition is assumed to be uniform, since few ranchers in the babassu zone incorporate leguminous forages that would increase carrying capacity and weight gain. There is presumed to exist a positive relationship between stocking rates and babassu productivity, based on the results for coconut palms (Rika et al., 1981). This positive effect is countered by the eventual decline in pasture dry weight production and hence liveweight gains as light transmission is reduced by palm density.

Optimum pasture growth is hypothesized to occur at somewhat less than 100 percent light transmission (zero palm density). Shading and litterfall is expected to have a positive effect on soil moisture and improve the quality of soils under palms. Shading may also have some direct effect on cattle productivity, as a result of lower perspiration losses during dry seasons. Thus, liveweight gain per ha. will peak at some point below 100 percent light transmission.

Based on the discussion in Reynolds (1980), however, it is assumed that pastures will bear zero animal units below 40 percent light transmission. Figure A.1 presents these relationships in graphical form.

---

[6] This assumption is based on studies by Kitamura et al. (1982), who rely on a quadratic model to estimate optimal stocking rates for three different eastern Amazonian pasture systems.

The functional form and hypothesized signs for the coefficients for the cattle and babassu production components of the model are as follows:

$$Y_b = a_1 + \beta_1 X_b + \beta_2 X_b^2 + \beta_3 X_b \qquad (2)$$

$$Y_c = a_2 + \beta_4 X_c + \beta_5 X_c^2 + \beta_6 X_b \qquad (3)$$

where X_b = number of adult palms per ha.;

X_c = stocking rate in number of head of cattle per ha.;

Y_b = annual production of babassu fruit in tons per ha.;

Y_c = liveweight gain per annum in kg. per ha.

where X_b = number of adult palms per ha.;

X_c = stocking rate in number of head of cattle per ha.;

Y_b = annual production of babassu fruit in tons per ha.;

Y_c = liveweight gain per annum in kg. per ha.

The two interaction terms relate in (2) the effect of nutrient feedback and grazing on babassu output, and in (3) the effect of light transmission level on pasture carrying capacity as well as some degree of positive response from shading of cattle, as well as litterfall and shade effects on soil improvement and thereby pasture productivity during dry spells.

It is hypothesized that the signs of B1, B3 and B4 would be positive and those of B2, B5 and B6 negative. The two second-order quadratic coefficients would be negative, reflecting the bell-shaped functional form for both babassu output and liveweight gains per unit land. Increase in the cattle stocking rate variable is hypothesized to have positive effects on palm productivity (B3), as fertilization is expected to increase the proportion of female flowering in babassu. The effect of light transmission on pasture productivity is expected to be negative (although liveweight gains are not expected to be optimized at 100 percent light transmission).

The objective function would maximize net revenues from the combination of palms and pasture to the landowner. Net revenue from pasture-babassu enterprises would be optimized by the following formula:

$$\max.\ R = Y_B P_B\ [1 - (w_B)] + Y_C P_C\ [1 - (w_C)] \quad (4)$$

where R = net revenue from the combined enterprises;

Y_B = output of babassu fruit in tons per ha. (as generated by expression (2))

Y_C = liveweight gain of cattle in kg. per ha. (as generated by expression (3))

P_B = farmgate value of babassu products per ton of fruit;

P_C = farmgate value of marketable beef per kg. live weight gain;

w_B = percentage of babassu product value paid to collectors; and

w_C = percentage of value of beef going to direct costs.

The model could be used to ascertain the sensitivity of landowner net revenue to changes in the babassu product price, which babassu products are sold (i.e. kernels, whole fruit, charcoal, etc.), and variation in wages. Since there is insufficient data available to estimate the coefficients statistically at this stage, the model is presented here as a set of hypotheses worth testing in future babassu research.

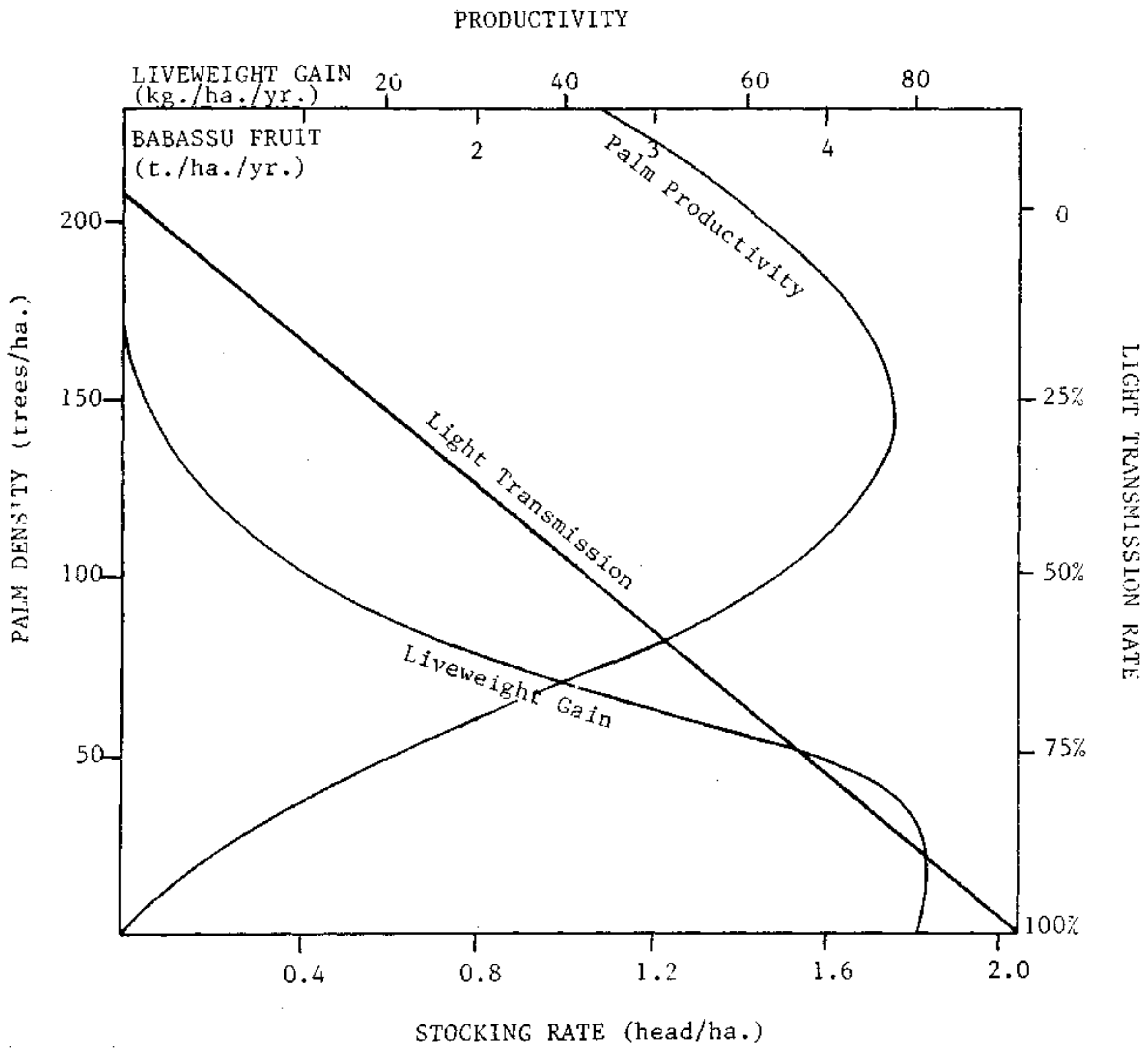

Figure A.1. Conceptual model of palm-pasture productivity.

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