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MANAGEMENT OF COMMODITY RESOURCES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT:

A SURVEY OF ENVIRONMENTALLY FRIENDLY PRODUCTS OF BRAZIL*

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Contents

Summary

The objective of this study is to identify means to promote commerce in natural and "environmentally friendly" products, using the situation in Brazil as an example. These products are characterized as goods whose production characteristics, potential for recycling, or benefits to the local or global environment are deemed more desirable than close substitutes available in the market. In the view of UNCTAD, such substitution would be valid if consumer satisfaction were kept equivalent or commensurate (UNCTAD, 1993, 1994).

To conduct this study within the Brazilian context, an initial selection of products was followed by detailed analysis of the characteristics of production and processing technology in each case. The product profiles also include a review of the history of production and trade, potentials and bottlenecks for production expansion to satisfy eventual consumer demand, and institutional issues of production organization, quality norms and certification procedures.

1. Product selection

The products selected for the Brazilian case were divided into several groupings, among which a few specific examples were identified for in-depth analysis, as follows:

(1) Organic products:	Coffee Arboreal cotton "Ecological beef"
(2) Hard fibres:	Sisal Piaçava palm
(3) Sugarcane biomass:	Fuel ethanol and bagasse
(4) Natural colorants:	Urucum seed
(5) Health beverages:	Erva-mate
(6) Tropical fruits:	Cupuaçu Cashew
(7) Extractive resources::	Brazil nut "Vegetable leather"
(8) Oilseeds and by-products:	Babaçu palm
(9) Palmito:	Açaí palm Peach palm
(10) Recycled products:	Paper and organic fertilizers

Among products presented in some detail, several are classified in the literature as non-timber forest products (NTFP). Those examined for this study were selected due to the existence of significant domestic or foreign markets. Other NTFP markets are incipient.

In general, the products studied offer one or more characteristics that are desirable from an environmental perspective. Such characteristics may include:

- sustainable origin (eg., extractive goods derived sustainably from tropical forests protect resources of global significance as biodiversity reserves; adaptability to semi-arid zone provides safety net from drought);

- amenable production technology (eg., reduced use of pesticides; nutrient cycling or recycling of agroindustrial effluents);

- appropriate processing systems (modest scale and simplicity, affording utilization by small farm cooperatives; cogeneration of energy);

- biodegradable or recyclable end product (ease of product disposal or reuse as inputs to other products);

- beneficial health effects (substitution of carcinogenic compounds in final products; worker safety).

At the same time, nearly all the products pose problems, whether from the viewpoint of market acceptance, adequacy of production infrastructure or resilience of the resource base to cope with market expansion. From an environmental perspective, the increased exploitation of forest products could be deleterious to just those values one hopes to enhance. The production of energy from sugarcane biomass has been contradictory in that it also implies inequities and social costs due to the displacement of food production and concentration in land tenure. Certification of sustainable origin is difficult for products not easily differentiable otherwise, urging considerable work on mechanisms to ensure that claims are verifiable.

Details on each of the products studied are summarized below.

2. Organic and "alternative" agricultural products

Traded agricultural commodities from Brazil have begun to vie for emerging "green" markets in response to domestic producers' loss in competitiveness in these markets and to declining primary commodity prices. One of the general difficulties is that of adopting norms for organic products. Producers are concerned to avoid governmental domination of the certification process, with a marked preference for independent certification schemes linked to the NGO movement.

Coffee: Coffee producers who lost ground during the price drop of the late 1980s initiated producer organization to seek alternative market channels. Reducing purchased input use, producers have increasingly adopted intercropping, shading with leguminous trees, and mulching as means to ensure adequate nutrient availability and control weed growth. Such a response enables some of these producers now to be categorized as "organic".

The prospects may be restricted, however, for Brazilian farmers to successfully enter the "green" coffee market organized by the Max Havelaar Foundation. "Smallholders" in Brazil operate coffee plantations that are considerably larger than those managed by small farmers in other countries where alternative market channels have been established. Secondly, Brazil's massive production, even if only a small proportion were directed toward the alternative market in Europe, could cause the bottom to drop out of that market. There could thus be a negative external effect of building environmentally friendly trade.

Another questionable feature of "organic" coffee production in Brazil is that the effect of price improvement in traditional markets has typically been to motivate farmers to return immediately and forcefully to the same high input techniques they had adopted prior to the crisis. This suggests that internalization of environmental concerns in commodity markets requires measures that target those producers who not only adopt but stick with environmentally friendly production techniques, making necessary a broader adhesion to certification procedures where segmented markets can be built.

Arboreal cotton: Mocó cotton is a perennial shrub resistant to moisture stress prevalent in semi-arid Northeast Brazil. It is produced in small farming systems involving intercrops and livestock, but usually furnishes the only ready source of cash income. Its long, smooth, fine, resistent and silky fibre is desired by industry, but received no price differential.

Responding to boll weevil infestation and decline in fiber quality over the past decades, extension agents promoted the eradication of mocó stands, and recommended substitution with herbaceous cotton. To do so implied shifting cotton growing from drought-prone to irrigated lands and the heavy and frequent application of pesticides.

As an alternative to such substitution, farm groups have recuperated mocó plantations with the objective of "ecological management of mocó cotton toward a productive coexistence with the boll weevil", produced without use of pesticides or other chemicals, thus qualifying the product for certification as organically grown. A small eco-priced market has evolved for such cotton, used to date in t-shirts produced under contract with Greenpeace. A broader market is desired, but will depend on further technical advances.

"*Ecological beef*": Brazilian cattle ranchers along with their neighbors in Argentina and Uruguay are rediscovering the benefits of range-fed beef cattle as a response to confined production techniques, hormone use and feed additives to promote weight gain applied in Europe. Consumers in Argentina and Uruguay have accepted beef bearing an ecolabel even with a higher price tag; potential for such an approach in Brazil is debatable due to the difficulty of discriminating range-fed cattle from that produced on pastures planted in deforested areas.

3. Recycled products

With its growing and highly urbanized population and consumption habits that closely imitate the wastefulness of the developed world, Brazil has witnessed a promising surge in concern with recycling over the past few years. A number of curbside collection systems have emerged, principally in the Southeast region, but also in Bahia in the backward Northeast. Such systems rely on the existence of significant markets for recycled containers, scrap metals and particularly paper, which have attracted a vast army of informal collectors. Today, for example, it is estimated that 41% of paper is collected for recycling by the informal sector. Yet, recycling is still responsible for a only a relatively small share of total industrial raw materials, except in paper and aluminum industries, due to abundant supplies of virgin materials and the high costs and transactions complexities involved in collection for recycling.

Solid waste in Brazil is unusually high in organic materials, corresponding to about 50% of municipal solid waste. This has offered the opportunity to develop organic composting systems that have been adopted in several cities. Such systems depend on some measure of waste separation to remove nonbiodegradable materials in so far as this is economical. Organic fertilizers produced by these systems are used in reforestation projects as well as in agriculture.

4. Hard fibres

Brazil produces two principal hard fibres. Sisal is cultivated for cordage and mats – much of which is for the international market, while piaçava fibre, derived from a native palm species, is extracted for domestic use in manufacture of cleaning equipment. Both products have exhibited declining demand in recent years due to substitution by synthetic fibres in international markets. They represent sources of biodegradable materials useful in a range of construction and agricultural activities.

Sisal: Resistent to the droughts prevalent in this region, sisal cultivation prevents desertification, and plays an important role in rural employment prospects. Recent reductions in sisal area harvested have arisen due to poor price terms in international markets and inadequate domestic price guarantees. Productivity has also fallen. Commercial intermediation in sisal is said to further constrain producer viability. A farmers' association has begun processing of sisal fibre to secure better producer prices through fibre quality control and direct export. Environmental characteristics of the product have not as yet been part of the organization's marketing strategy.

Piaçava: Due to a long-standing decline in prices due to competition with synthetic fibres, piaçava extractivists have been discouraged from expanding production. Only about 5% of piaçava fibre is exported, due to the preference for long fibres in international markets. Piaçava stands have hence been replaced with other land uses. Damage to palms during cutting which often destroys inflorescences and fruit, coupled with the low value of fibres threaten their sustainable production. There have been no decisive efforts to link piaçava production to sustainable management and conservation of the threatened Atlantic Forest, a current priority among environmentalists.

5. Sugarcane biomass

With an extensive land mass and fertile soils, Brazil has had notable success in substituting petroleum-based fuels with renewable biomass sources. The government's Pro-Álcool programme stimulated expansion in sugar cane planting and distilling that increased national fuel ethanol production 80 times from 1976 to the current 12 billion litres/year, providing nearly one quarter of national liquid fuel requirements. Socio-environmental benefits from substitution of gasoline by ethanol include: agroindustrial employment, energy cogeneration and vehicle emissions reduction, that besides improving urban health conditions could help in combating the threat of global warming.

Subsidies necessary to maintain production levels adequate to supply internal demand have been criticized due to declining global petroleum prices. Furthermore, negative environmental effects have been polemical, and include the substitution of prime agricultural land otherwise used for food production, gas and particulate emissions from cane burning, and generation of large volumes of distillate effluents, whose oxygen demand imperil aquatic biota and water supplies. Technical measures to overcome these drawbacks, such as electrical cogeneration from cane bagasse and the recycling of distillate for use in irrigation and fertilization of cane fields, have partially justified maintenance of the programme. The export of excess ethanol to northern consumers could represent a means to reduce global greenhouse gas emissions.

6. Urucum seed colorant

The seeds of the urucum flower – derived from a shrub widely cultivated in the neotropics – provide bixine, a major global source for natural red dye and colorant. The discovery of carcinogenic properties in the synthetic substitute, Red Dye No. 3, led the U.S. FDA to ban it. An equivalent European prohibition has further stimulated interest in urucum among growers, food processors and cosmetics firms. In 1991, 8,000 to 9,000 tons of seed were destined principally for the domestic market, for fabrication of colorants. Exports expanded rapidly over the 1985-94 period.

Low bixine content, mold, purity and deformities have seriously impeded market penetration. More productive varieties and more efficient industrial processes, seed classification mechanisms and norms for product quality, including identification, quality, appearance and packaging are among options being pursued to improve competitiveness. Brazilian growers have formed an Association of Producers of Natural Colorants that seeks to overcome some of the bottlenecks facing product and trade expansion.

7. Health beverages: erva-mate

A tonic stimulant, herbal tea derived from erva-mate bushes remains one of the most popular beverages consumed in the Southern Cone. Its management in watershed catchments and planting into agroforestry systems makes it an important part of the regional farm economy and generates environmental benefits. Erva-mate output is about 145,000 tons, worth US$ 200 million. Exports represent a small part of this total; most of this goes to neighboring Uruguay; other buyers include natural and health food retailers in the U.S., Europe and Japan. Among the tea's medicinal properties, erva-mate is taken as a stimulant (caffeine), diuretic and digestive aid. Besides the strong regional market, erva-mate trees aid in soil recovery, serving as an economically viable means to augment small farm income in sustainable agroecosystems.

8. Tropical fruits

Cupuaçu: A relative of cocoa, cupuaçu fruit pulp is prized in the Amazon basin for juices, jellies, ice cream and liqueur fabrication; its seeds serve as a base for white chocolate. Originating in native forest, more intensive planting of cupuaçu can aid in generating income for forest peoples, complementing other efforts toward tropical forest conservation. Furthermore, the crop does not require significant chemical inputs. This natural product faces growing demand in southern Brazilian markets; there is some interest overseas in its use in ice creams.

There is some controvery regarding the prospects for development of this product, since planting has rapidly expanded to as many as two million trees in recent years. Lack of infrastructure to handle the intense growth in raw cupuaçu supply and consumer demand is a drawback that can weaken future market prospects. Producer organizations have formed in efforts to develop local capacity to freeze and store cupuaçu pulp in volume and quality to match this growth.

Cashew: A multipurpose tree suited to poor soils, cashew is recommended for rehabilitating poorly managed pastures or for shifting cultivation areas where fallow periods have been reduced due to population pressure. Native to Brazil's semi-arid northeast coast, cashew tolerates drought and high temperatures. The agroindustry provides cash income and both rural and urban employment that helps to stave off deprivation in drought years.

Brazilian cashew is now second in exports to India. In 1992, 38 thousand tons of cashew nuts were exported. During the past two decades, there has been an accelerated expansion in cashew cultivation, motivated principally by fiscal incentives and high prices for nuts and derivatives in the domestic and foreign market. However, the product stands competition with a number of substitutes, and there is hence a high price elasticity of overseas demand. Beginning in 1984, a large volume of nuts of Indian origin began to enter the United States market, a principal importer, forcing Brazilian growers to assume a more competitive stance.

The nut is the true fruit of the species, while the succulent and fibrous "pseudofruit" is a by-product used in juices and confectionaries. Cashew by-products include cashew nut shell liquid (CNSL), exuded during roasting, and a resinous gum exuded from the trunk. The latter have potential to increase value added to the crop. CNSL is a phenolic substance used for water-proofing and as a preservative, while the resin may be substituted for gum arabic.

9. Extractive resources

Brazil nuts: Due to the crisis in natural rubber, Brazil nut gathering has become a principal source of cash to ensure survival of extractivist communities in the Amazon, today considered synonymous with forest conservation. An important source of income and food, Brazil nuts provide protein and calories to forest peoples. Seasonal complementarity with rubber tapping offers a year-long flow of income. Brazil nuts generated an annual average of nearly US$ 30 million in export revenues to Brazil over the last decade.

A recent experiment in cooperative Brazil nut processing to add value to the product for extractive communities has had mixed results. High social costs, and the lack of a sufficient number of workers accustomed to wage labour, undermined the factory's competitive position vis-à-vis Brazil nut industries based, paradoxically, in Bolivia. The difficult tradeoff between improving rural living conditions and ensuring product competitiveness may pose a significant barrier to achieving consumer satisfaction and environmental protection through expanded output of natural products.

"Vegetable leather": A recently developed product, "vegetable leather" is made from natural latex collected from rubber trees in extractive reserves of the Amazon. The latex is poured over cotton sacks and vulcanized, producing a dark brown material akin to leather. Traditional rubberized (non-vulcanized) sacks used by tappers inspired the search for a higher quality product destined for international markets for use in boot manufacture.

Naturally gathered latex suffered a recent price drop with the loss of Brazilian government trade protection. Vegetable leather offers the prospect of an improved price (up to triple that of latex) for a value-added product. Eighty per cent of all vegetable leather currently produced is sold to Deja Shoe, an American company that produces a low boot. Efforts are being made to improve quality standards and to manipulate the raw product, for example improving colour standardization and developing post-production care procedures.

Substitutability of the product can be avoided with the development and retention of the specialized market niche. In the "green" market, companies such as Aveda have shown interest in using vegetable leather in packaging. The handbag industry is another potential customer.

10. Oilseed and by-products: babaçu palm

Monospecific stands of babaçu palms cover extensive areas of Brazil's pre-Amazon region, where vegetable oil industries based on manual kernel extraction arose over the past half-century, considered the largest such industry in the world based on a wild plant. Babaçu products contributed on average 22% of household income from all sources to as many as 420,000 impoverished rural households. High biomass turnover makes it possible for shifting cultivators to cut palm leaves rather than stems, thus benefiting from a multitude of products derived during the fallow cycle.

Oil output from babaçu kernels peaked at 80,000 tons per year in the late 1980s, corresponding with extraction from 1.2 million tons of fruit, having a final market value of over US$ 40 million. Due to competition with imported substitutes and alterations in the structure of detergent and edible oils markets, the prospects for babaçu oil must be considered fairly bleak. Efforts to improve prospects focus on obtaining a larger number of by-products and an ecolabel premium to support community enterprise.

Dispersed and unproductive stands combined with the distance and inaccessibility of rural settlements have made gathering and transport costs prohibitive at large scale. Fruit processing has also been a bottleneck. Due to the random positioning of kernels inside the endocarp, variable size of fruit and differences in proportions among fruit constituents, industrialization attempts have failed. Small-scale community-operated processing schemes could be more socially acceptable, and could overcome logistical problems in transport from dispersed sites.Rural producers’ organizations are actively engaged in testing technical and marketing alternatives, including community oil and soap manufacture, charcoal and starch production from different fruit components. Marketing focuses on the social and environmental benefits obtained.

11. Palmito

Palm heart represents a major source of income for rural households and responds to strong international demand. The palmito agroindustry in Brazil, the principal world producer, consumer and exporter, is based practically entirely on extraction of native palms. Exports, corresponding to 90% of production, have stabilized at US$ 15 million over the last few years, based on average prices of over US$ 2,000 per ton of canned palmito.

Açaí: The majority of palmito produced in Brazil today originates from açaí palms. These are native trees that grow throughout the Amazon estuary, yielding both a fruit "wine" having high energy content and considerable demand among low-income residents, and palm heart derived from the base of the stem. The great advantage of açaí is that it grows in clumps; the cutting of one stem does not result in mortality to the clump unless producers do not exercise care in extraction. In the 1980s, açaí production supplanted that from its relative, the jussara palm, formerly exploited for palmito in coastal Atlantic Forest areas, when these palms were decimated by overexploitation. Now, the number of easily accessible native stands of açaí have been equally reduced through destructive exploitation.

It appears that palmito production by extraction from native stands of açaí has reached a limit; supply in the future will be based on extraction from more distant and hence more costly sites, or through commercial planting of substitutes. Improved management of existing açaí stands would be a desirable approach to avoid such costly substitution, but controls are inadequate at present to monitor extraction, or motivate producers to protect immature stems. One means to improve this situation is to adopt rigorous controls over the size of stems that industries may accept.

Pupunha: The peach palm (pupunha) represents a potential alternative to açaí, that can be cultivated in more intensive production systems. Adapted to low fertility soils, pupunha begins production within two years, producing large-diameter palm heart, and weight greater than that derived from açaí, characteristics desirable to the industry. On the other hand, production costs are relatively higher than those necessary for extractive production of açaí, due to the need to establish plantation production. Nevertheless, pupunha is a permanent crop that can be managed for continuous harvesting of palm heart, and can alleviate pressures on native açaí stands threatened by excessive exploitation.

References

UNCTAD (1993). "Experience concerning environmental effects of commodity production and processing: synthesis of case studies on cocoa, coffee and rice" (TD/B/CN.1/15), Geneva.

UNCTAD (1994). "Reducing the environmental stress of consumption without affecting consumer satisfaction" (TD/B/CN.1/25), Geneva.

I. Introduction

This study has been prepared for the United Nations Conference on Trade and Development (UNCTAD), according to terms of reference which specify, *inter alia*, that the study would provide:

- An annotated list of products which the producers and exporters of the selected countries claim to have environmental advantages... The products would be classified according to the nature of their environmental friendliness...

For each product, the study would also provide:

- A brief description of why it is thought to be environmentally friendly;

- Indications of which currently used products it could substitute;

- An initial assessment of its potential on world markets;

- An initial examination of the constraints which may be encountered in expanding its production and international trade..., and

- Preliminary indications of policy options and of technological requirements for increasing the sustainable production and "environmental friendliness" of the products.

It is hoped that this study will assist in identifying means to promote commerce in natural and "environmentally friendly" products. The latter are characterized as goods whose production characteristics, potential for recycling, or benefits to the local or global environment are deemed more desirable than close substitutes available in the market. In the view of UNCTAD, such substitution would be valid if consumer satisfaction were kept equivalent or commensurate (UNCTAD, 1994).

In the case of Brazil, an initial selection of products that could be classified as "friendly" in these terms was made. This selection was followed by a detailed analysis of the characteristics of production and processing technology for each product selected. The product profiles include, furthermore, a review of the history of production and trade, potentials and bottlenecks for production expansion to satisfy eventual consumer demand, and institutional issues of production organization, quality norms and certification procedures.

The products selected for the Brazilian case were divided into several broad groupings, among which a few specific examples were identified for in-depth analysis (see table 1).

Table 1. Products studied

Category	Product	Key "friendliness" attributes	Market potential
(1) Organic products	Coffee	Smallholders; reduced toxicity	Export volume may exceed demand
	Arboreal cotton	Smallholders; reduced toxicity; biodiversity	Insufficient price advantage
	"Ecological beef"	Natural range; reduced toxicity/hormone use	Restricted but excellent
(2) Hard fibres	Sisal	Smallholders; biodegradable	Undervalued due to substitutes
	Piaçava palm	Smallholders; biodegradable; biodiversity	Large domestic demand but low value
(3) Sugarcane biomass	Fuel ethanol	Urban air quality; CO_2 reduction; effluent reuse	Limited export prospects;
	Bagasse	Potential electrical cogeneration	Declining domestic demand
(4) Natural colourants	Urucum seed	Smallholders; substitute for toxic dyes	Excellent export prospects
(5) Health beverages	Erva-mate	Smallholders; land recuperation	Demand confined to Southern Cone
(6) Tropical fruits	Cupuaçu	Smallholders; agroforestry	Potential oversupply; domestic use
	Cashew	Land recuperation; smallholders	Inelastic export demand
(7) Extractive resources	Brazil nut	Extractivists; forest protection	Good for nontraditional export options
	Vegetal "leather"	Extractivists; forest protection	Limited export market, good prospects
(8) Oilseeds, by-products	Babaçu palm fruit	Extractivists/smallholders; land cover	Imported substitutes; low value; good by-product potential
(9) Palmito	Açaí palm	Smallholders; agroforestry	Decline from overexploitation
	Peach palm	Smallholders; agroforestry	Excellent export growth potential
(10) Recycled products	Paper	Reduced celulose impacts; employment indigents	Good domestic opportunities
	Organic fertilizers	Reduced municipal effluents/sludge disposal	Incipient domestic use (gratis)

The table on the previous page characterizes products chosen, key "friendliness" attributes and unresolved problems associated with such a categorization. In general, the products studied offer one or more characteristics that are desirable from an environmental perspective. Such characteristics may include:

- sustainable origin (eg., extractive goods derived sustainably from tropical forests protect resources of global significance as biodiversity reserves; adaptability to semi-arid zone provides safety net from drought);

- amenable production technology (eg., reduced use of pesticides; nutrient cycling or recycling of agroindustrial effluents);

- appropriate processing systems (modest scale and simplicity, affording utilization by small farm cooperatives; cogeneration of energy);

- biodegradable or recyclable end product (ease of product disposal or reuse as inputs to other products);

- beneficial health effects (substitution of carcinogenic compounds in final products; worker safety).

As will be noted, the "environment" associated with these products is taken to include social as well as physical features and concerns. In Brazil, as in much of the developing world, poverty is a chief cause and result of environmental problems. For a product to be environmentally friendly thus implies that it must help in the resolution of social as well as physical conflicts that affect the quality of human life. To avoid confusion for readers, the issue of environmental friendliness has been distinguished from social friendliness where warranted by denoting those selected primarily on the latter grounds as "fairly traded" products.

Although most of the products studied offer important advantages from an environmental perspective, nearly all also pose problems, signalled by the unresolved issues in the table above. Such problems stem from difficulties in market acceptance, inadequacy of production infrastructure or insufficient resilience of the resource base to cope with market expansion. As one example of the latter problem, for example, the increased exploitation of forest products could be deleterious to just those values one hopes to enhance. Although production of ethanol from sugarcane biomass is beneficial for urban air pollution and greenhouse emissions, the expansion of cane production also implies inequities and social costs due to the displacement of food production and concentration in land tenure.

Among products presented in some detail, several are classified in the literature as non-timber forest products (NTFP). It is not necessarily the case that NTFP are either environmentally friendly or fairly traded, despite their assumed beneficial aspects in so far as they are normally extracted from natural forest ecosystems. Table 2 provides details on NTFP selected for analysis, for which established markets already exist. Due to deforestation pressures in natural forests, resources from which these products are derived have been decimated over the past decades, in some cases making them incapable of sustaining output. Substitutes for such extractive resources that can be produced in planting schemes are being increasingly proposed as a solution to resource depletion.

Table 2. Non-timber forest products studied

Common name	Scientific name	Products	States produced	Value 1989
Açaí	*Euterpe oleracea*	Fruit, palmito	PA, AP	$246 million
Babaçu	*Orbignya phalerata*	Oil,charcoal,starch	MA, GO, PI, CE	$73 million
Castanheira	*Bertholletia excelsa*	Brazil nuts	RO, AC, AM, PA, RR	$14 million
Palmiteiro	*Euterpe edulis*	Palmito	SC, PR, SP	$3.6 million
Piaçava	*Attalea funifera*	Hard fibres	BA	$245 million
Seringueira	*Hevea brasiliensis*	Latex, "veg. leather"	AC, RO, AM,PA	$60 million

Source: IBGE, *Anuário Estatístico*, various years.

Notes: Values refer to US$ of 1989. The value of piaçava produced in 1988 was used, due to inconsistency in the valu e reported for 1989. States referred to are: AC-Acre, AM-Amazonas, AP-Amapá, BA-Bahia, CE-Ceará, GO-Goiás, MA - Maranhão, PA-Pará, PI-Piauí, PR-Paraná, RO-Rondônia, RR-Roraima, SC-Santa Catarina, SP-São Paulo.

Environmental friendliness concerns not only the technology used for production but also the form of processing, marketing channels and fate of residuals. Where possible, information reflecting such cradle-to-grave concerns has been included in the study. Although a detailed study of recycling industries has not been accomplished here, characteristics of Brazilian recycling activities and potentials are discussed.

A particular sticking point in the expansion potential for friendly products is that of quality certification. The certification of sustainable origin or ecolabelling is a complex approach for products not easily differentiable otherwise, urging considerable work on mechanisms to ensure that claims are verifiable. The status of certification efforts regarding the products described in the report is described where relevant.

References

UNCTAD (1994). “Reducing the environmental stress of consumption without affecting consumer satisfaction” (TD/B/CN.1/25), Geneva.

II. Organic and “alternative” products

Organic farming and associated movements have only recently begun to gain momentum in Brazil, stemming from a variety of distinct perspectives, including so-called alternative, biodynamic and organic agriculture *strictu sensu*. The alternative agriculture movement has arisen as a central focus of technical assistance by non-governmental organizations to small farmers on marginal lands, and incorporates community development, marketing and political organization. The biodynamic and organic agriculture movements are more atomized, being directed principally toward the use of non-chemical pest controls and fertility enhancement by individual growers, primarily of farm fresh organic fruits and vegetables. Such products are now routinely available in farmers' markets in major cities. The national Organic Agriculture Association, linked with the International Federation of Organic Agricultural Movements (IFOAM), is based in São Paulo and by end of 1994 boasted over 1,000 members (AAO *Boletim*, 12/94).

Organizations associated with these movements recently participated in an Agriculture Ministry initiative to create a joint government/non-governmental organization (NGO) Commission and normative guidelines on organic products. Of particular concern to the movement is the need to avoid governmental domination of the certification process, with a marked preference for independent certification schemes linked to NGOs.

Besides the growing importance of organic fruits and vegetables in Brazil, a parallel movement has arisen in relation to traded agricultural commodities, accompanying this process at the international level. In general, this has occurred as a response to erosion in Brazilian producers' competitiveness in these markets and to a real decline in primary commodity prices in international markets. In the discussion below, we concentrate on developments in organic and "alternative trade" in coffee, arboreal cotton and "ecological beef" production in Brazil as an expression of these trends.

1. Organic and "alternative" coffees

Coffee production — once the principal source of foreign exchange and still a sector that is responsible for a good share of rural employment in Brazil — declined in its proportional contribution to trade receipts beginning in the mid-1960s, and lost ground in absolute terms due to plummeting prices since 1986. Brazilian coffee growers had been subject to a radical programme of production reorganization in the 1960s, which promoted the eradication of 1.5 billion trees in an effort to improve productivity. Subsequently, a technical package with subsidized credit stimulated coffee plantation renovation with improved species, fertilization and pesticide recommendations, prohibiting intercropping and minimizing shade (UNCTAD, 1993; APTA-CERIS-IDACO-PROTER, 1993). Former coffee plantations lapsed into pasture and secondary forests.

Before government intervention, coffee growing in Brazil can be considered to have been based in up to 40% on "organic" or low-input production techniques. Growers relied on natural soil fertility to provide adequate productivity during a 7 to 10-year period, after which lands were abandoned. Lack of producer capitalization made use of defensive pesticides too costly, so that the quality of many arabicas produced in this period was poor. These coffee groves were substantially eliminated during the eradication programme. Those which remained in production adopted the government's technical recommendation package, thus boosting overall productivity and enhancing competitiveness in more discerning markets (Agostinho Guerreiro, pers. comm.). Output in coffee climbed from the mid-1970s through the late 1980s, migrating from areas in southern Brazil that had been subject to frost, to new areas of specialization in Minas Gerais, Espírito Santo and the Legal Amazon, where robusta varieties are now also grown (Daviron, 1992).

Despite improved productivity and sustained market demand during this latter period, growers were forced to reduce use of chemical inputs during an ensuing period of depressed prices from 1987-93. This period, corresponding with a collapse in the economic clauses of the international coffee agreements, led to a new cycle of crop abandonment. Estimates of the impact of this cycle suggest that as many as 250 thousand small farmers, rural workers and their families may have been forced to abandon coffee production (UNCTAD, 1993).

While in some areas declining prices made it impossible for small coffee producers to remain in production, others were able to sustain a modest level of output and to invest in efforts towards producer organization to seek alternative market channels. Because many of these farms had applied chlorated pesticides and cupric fungicides as a standard practice prior to the drop in prices, their product cannot be considered to be certifiably "organic", until after a period of transition to eliminate residual chemical buildup in soils and tree tissues (Dickinson and Lepp, 1985). Producers have increasingly adopted intercropping, shading with leguminous trees, and mulching as means to ensure adequate nutrient availability and control weed growth (Babbar and Zak, 1994).

However, the principal objective of market segmentation in small farmer coffee production has been to qualify for registry and export by roasters who participate in the Max Havelaar Foundation network in Western Europe. Such registry is limited to organized groups of farmers that produce good quality coffee on areas typically from 2 to 4 ha, on which they depend for a principal share of their income. Those who qualify are able to market their coffee with the Max Havelaar seal, widely recognized in European supermarket chains, and so secure a price premium that enables producers to as much as double net income. The organic characteristic is not a principle objective of this registry, although many such producers are moving towards such technologies. In this sense, the environmental characteristic of alternative coffee is more closely meshed with a social equity objective than with purely physical environmental concerns.

In Brazil, a few isolated groups of coffee growers in Rondônia, Espirito Santo and Minas Gerais have sought or obtained Max Havelaar registry. The technical assistance organizations that have been officially recognized to orient growers in this sense have typically adopted "alternative technologies" (low-input, labour intensive and resource protective techniques that can be used by small farmers on marginal lands) as a starting point (APTA-CERIS-IDACO-PROTER, 1993).

1.1 Problems affecting expanded "alternative" coffee production

The prospects for expansion in Brazilian producers' involvement in this market segment remain dubious, however, due to concern among those seeking to strengthen small farmers' organizations. This concern stems from two arguments regarding Brazilian coffee growing. First, the majority of smallholders in Brazil operate coffee plantations that are larger by far than those managed by small farmers in other countries where alternative market channels are sought (according to Zylberstajn et al. (1993), "mini" and small coffee farms in Brazil are defined as those under 50 ha). Secondly, Brazil's massive production, even if only a small proportion were to be directed towards the alternative market in Europe (still only between 2 and 4% of total consumption in the Low Countries, France and Germany) could result in the bottom dropping out of the market. There could thus be a negative effect of competition in the "solidarity" market that has been constructed (Agostinho Guerreiro, pers. comm.).

Another questionable feature of "organic" coffee production in Brazil is that the effect of price improvement in traditional markets has typically been to motivate farmers to return immediately and forcefully to the same high input techniques they had adopted prior to the crisis (UNCTAD, 1993). This suggests that internalization of environmental concerns in commodity markets requires measures that target those producers who not only adopt but stick with environmentally friendly production techniques, making necessary a broader adhesion to certification procedures where segmented markets can be built.

2. Organic arboreal cotton

Much of the cotton produced in semi-arid Northeast Brazil is derived from an arboreal species known as "mocó" cotton (*Gossypium hirsutum* Marie Galante Hutch), a perennial shrub considerably more resistent to moisture stress than is the herbaceous variety, maintaining production under the uncertain rainfall of 200 to 250 mm annually prevalent in the "drought polygon". Mocó cotton is tightly integrated within smallholder agropastoral systems in the region, typically produced as an intercrop with maize and cowpea, and furnishes livestock forage in the form of crop residues. Its fiber is long, smooth, fine, resistant and silky. Annual production during the 1970s averaged 200 thousand tons in the state of Ceará, the principal producer, but declined dramatically beginning in the mid-1980s. This decline was due in part to infestation by the boll weevil (*Anthonomus grandis* Boheman), but more generally to a secular decline in soil fertility and disdain on the part of regional agricultural research and extension agencies. Today, mocó cotton is only a minor contributor to regional textile industry demand, mostly supplied by imported raw material (Lima, 1993).

In response to the spread of boll weevil and a decline in fibre quality, extension agents promoted the eradication of mocó stands, arguing that they harbored the pest, and called for substitution with herbaceous cotton. Such substitution implied the shift of cotton growing from drought-prone to irrigated lands, and the application of heavy and frequent doses of pesticides. Neither of these measures could be accomodated by the small farmers who rely on mocó cotton for much of their cash income and who are excluded from access to the resources necessary for intensive cultivation. In addition, pesticides applied in cotton pose serious environmental and health risks.

Beginning in 1989, the alternative agriculture organization ESPLAR has worked with small farm groups in the state of Ceará to recuperate mocó farming systems, focusing on the critical issues of soil fertility and seed degeneration and their link with crop productivity and fibre quality. A working group of farmers and technicians evolved a set of guidelines for what they described as "ecological management of mocó cotton toward a productive coexistence with the boll weevil" (Lima, 1993). An emphasis was placed on erosion control via contour planting; intercropping with *Leucaena leucocephala*, a leguminous nitrogen-fixing tree for ground cover, fertility enhancement and forage; and the use of an improved early-bearing variety of mocó (4M) developed by the Brazilian national agricultural research corporation EMBRAPA. The 4M variety is more resistant to boll weevil infestation due to its precocity in flowering, which allows it to escape the period of greatest pest attack. These measures enabled farmers to attain yields over double the average for the region during drought years.

Ecologically managed mocó cotton is produced without use of pesticides or other chemicals, thus qualifying the product for certification as organically grown. Greenpeace of Brazil, through the intermediation of ESPLAR, has brokered the entry of this cotton into domestic markets (the principal buyer is Filobel in Jundiaí, São Paulo) for use in that organization's promotional t-shirts. This alternative market channel enabled producers to obtain a significant price advantage over conventionally grown cotton of 30% in 1993 (increases in international cotton prices forced Filobel to reduce the premium to 10% on sales from the following year's harvest, effectuated in late March 1995). The buyer also assumed transport costs and value-added taxes. However, the volume shipped to Filobel (10 tons over the initial two-year trial period) has only been sufficient to supply the restricted demand by Greenpeace for its t-shirts (Pedro Jorge Lima, pers. comm.).

2.1 Problems and solutions for organic mocó cotton production expansion

The most serious difficulty affecting mocó cotton expansion is, paradoxically, a two-year period of normal or excessive precipitation, that has stimulated boll weevil attack, further compromising plantings that had survived the drought period in the early 1990s. Drought-resistant varieties and biological management techniques are no match to this combined stress, which has forced ESPLAR to rethink its research and development strategy. Farmers may now be reticent to risk further ventures with this product, however.

Should these problems be overcome, organic cotton growers can expect to reap a more significant financial advantage by cooperatively installing cotton gins that would enable them to extract and conserve seed quality and ensure organic sources. By-product options such as cottonseed oil and feedcake could also be considered. Further research is needed on long-term crop response to the management proposals, as well as to articulate a growing network of organic cotton growers throughout Brazil's Northeast region (ESPLAR, n.d.).

3. "Ecological" beef

Responding to the international tendency to place a premium on natural and organic products, Brazilian cattle ranchers along with their neighbors in Argentina and Uruguay are rediscovering the benefits of range-fed beef cattle as a response to confined production techniques applied in Europe. The recent outcry against inhumane conditions in cattle raising under confinement has reinforced this view. Widespread use of antibiotics and hormones in animal rations to increase weight gain and promote better feed conversion efficiency has also drawn criticism.

So-called "ecological" beef is obtained from animals fed on natural extensive range. Such pastures are not treated with fertilizers or pesticides. The cattle grow more slowly than under confined conditions, and must expend more energy in the process, but the resulting beef is free of growth hormone and other chemicals, and has lower levels of fat and cholesterol, conserving protein. The only controls employed are vaccines against aftosa (hoof rot) and parasite removal baths.

In Argentina, ecological beef production systems began to be developed in 1992 on three experiment stations; today their use is widespread. Consumers have accepted beef produced in this way that bears an ecolabel and a higher price tag. The National Institute of Agricultural Technology and the National Animal Health Service guarantee quality control.

In Uruguay, the generally high standards of range-fed cattle management, free of aftosa and parasites, is well known, allowing ranchers to dispense with the use of sanitary treatments and qualify their beef for the ecolabel.

3.1 Problems affecting expansion in production and trade in Brazil

Southern Brazilian range-fed cattle is of consistently high quality, and production systems are similar to those applied in Argentina for ecological beef, both due to the similarity in ecosystems and the origin of the cattle species. In other parts of Brazil, such as the Central-West and Southeast regions, where pastures are often planted after clearing and burning of forests and where herbicides and chemical fertilizers are employed, the ecolabel would be difficult to apply. In fact, the complexities of certification under such heterogeneous conditions may make it difficult for Brazilian producers to qualify for such markets.

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III. Recycled products[1]

With its growing and highly urbanized population and consumption habits that closely imitate the wastefulness of the developed world, Brazil has witnessed a promising surge in concern with recycling over the past few years. In 1992, in an effort to ensure that recycling evolves beyond its current unprestigious status to evolve as a modern industry, a number of firms in the food products, paper and packaging, and cleaning sectors organized the Brazilian Recycling Commitment (CEMPRE), a non-governmental organization that expects to play a catalytic role in advancing the recycling cause in Brazil. To do so, according to the organization's executive director, requires the perception that recycling in developing nations follows a very different path from that in the North (Wells, 1994).

Rapid urbanization (Brazil's population is now nearly 80% urban) has meant that there is increasing pressure on available space to deposit the 90,000 tons of municipal solid waste (MSW) Brazilians generate daily. For this reason, a great deal of clandestine dumping occurs, primarily on open lands or in wetlands or waterways, which represent major environmental hazards. About half of this waste consists of organic materials that should be composted or incinerated rather than dumped. The opportunity to develop organic composting systems was adopted in several cities, and there are several current rather controversial proposals for high temperature incineration in São Paulo. Such systems depend on some measure of waste separation to remove nonbiodegradable materials in so far as this is economical. Composting is now incorporated within this system to produce organic fertilizers used in reforestation projects and agriculture.

Of the remaining volume of solid waste, 30 to 40% represents glass, paper, plastics and metal, part of which can be recycled. In the past, a large volume of this material has been lost due to quality problems arising from the organic mixture. The small part that has been recycled is gathered by scavengers in dumps and along city streets and sold at a pittance. (One estimate is that a scavenger must collect ten returnable bottles to be able to buy a demitasse of coffee.) The trend toward "one-way" bottling has exacerbated this problem, rather than generated a substantial new supply of glass fragments for production of new containers.

Solutions for these problems must ensure a more adequate return to the recycler, and a reduction in transactions costs to the industry. One measure increasingly adopted is that of selective separation of MSW. A number of curbside collection systems have emerged, principally in the Southeast region, but also in Bahia in the backward Northeast. Such systems rely on the existence of significant markets for recycled containers, scrap metals and particularly paper, which have attracted a vast army of informal collectors. Today, for example, it is estimated that 41% of paper is collected for recycling by the informal sector, and that the number of cities with selective collection programmes in operation has grown rapidly (from 54 in 1989 to 84 in 1994). Nevertheless, the steeply higher costs of selective waste collection (about 10 times that of conventional systems), and the low financial return on these costs have made it unattractive for private-sector investment.

Although reusable bottle return systems are well institutionalized, growing production of "one-way" containers represents an important raw material market for the bottling industry.

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[1] Information for this segment was derived from the seminar "The Economics of Recycling", sponsored b y CEMPRE and IPEA-Rio, Rio de Janeiro, 24–25 August, 1995; from Serôa da Motta (1995) and Wells (1994).

Aluminium containers are now readily accepted for recycling. Brazil currently imports a significant volume of metal waste for industrial purposes (US$ 28 million in 1992; $ 40 million solely in copper residues in 1994); part of these imports could be substituted from domestic sources.

Table 3 shows the proportional share of recycled materials in the total volume of raw materials used in industrial processes in Brazil. Only in the case of aluminum and paper do the levels of recycling practiced achieve anything resembling those in Northern nations. Plastics recycling has grown from a very shallow base.

Table 3. Recycling Rates in Brazil, 1994

Recycling rate	*%*
Paper	37
Plastics	11
Glass	18
Steel	25
Aluminum (total)	11
Aluminum cans	56

Source: Serôa da Motta (1995)

In cooperation with economists at the Institute for Applied Economic Research of the Brazilian Ministry of Planning, CEMPRE has recently undertaken a series of sectoral analyses to identify financial and legal incentives and market formation strategies that can promote greater recycling in Brazilian industry and municipalities. A proposal for value-added tax differentials for recycled products has been put forward. The trend toward industrial compliance with ISO 14000 standards is likely to promote a greater adherence to recycling in the future, particularly by exporting industries.

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IV. Hard fibres

Brazil produces two principal hard fibres. Sisal, which originated in Mexico, is cultivated for fabrication of cordage and mats, while piaçava, a native palm species, is extracted for domestic use in manufacture of brooms and scrub brushes. Both products have exhibited declining demand in recent years due to substitution by synthetic fibres in international markets. They represent sources of biodegradable materials useful in a range of construction and agricultural activities.

1. Sisal

1.1 Product characteristics and environmental attributes

Agáve sisalana or sisal is a principal raw material for fibre production in the semi-arid tropics, due to its high resistance to breakage, high yields and climatic resistance. Originally found in the eastern Yucatan, sisal was introduced to Brazil in 1903, where in the semi-arid Northeast, principally the state of Bahia, conditions particularly appropriate for cultivation can be found. Because sisal is resistant to the droughts prevalent in this region, its cultivation prevented desertification. Sisal became an important factor in the survival and permanence of rural populations in the zone of its cultivation (SAGRIIR-BA, 1991).

In Brazil, sisal is planted in an extensive fashion with rudimentary techniques. Soil preparation is primarily manual, and it is rare that chemical inputs will be used, as a means to avoid production costs. Native vegetation is cut and burned before planting.

Sisal propagation is usually done from bulbs grown in nurseries and then transplanted to the field. Spacing varies between 4000 and 6000 plants per ha. Seedlings can be mulched with sisal waste which is more effective than inorganic fertilizers. Weeds are controlled by hand, a practice that is important during the first two years.

A plant produces 200 to 250 leaves in a lifetime. The first cut is made after the plant reaches three years of age. Leaves are cut by hand and transported to the factory, a standard daily individual load being of 2,700 leaves (90 bundles of 30). If cutting is delayed too long, fewer leaves are produced per plant, fibre percentage decreases, and yield decreases. Overcutting results in smaller leaves and higher harvesting costs. From 20 to 24 leaves must be left intact at each cutting to enable new leaves to emerge. In Brazil, this technique is not respected adequately, and overcutting harms productivity and fibre quality; yields here are only one fourth those obtained in West Africa, where this practice is rigorously followed. In general leaves weigh about 0.7 kg and contain on average 4% fibre.

To obtain fibre, the leaf undergoes rudimentary processing by mechanical decortification, using mobile equipment. Larger properties possess fixed plants with more advanced technology, involving a continuous cycle of fibre removal through decortification, beating and vibration that removes the pulp. This process should occur within 48 hours after harvest.

After processing, the resulting fibre is transported to the cities, where it is beaten, combed, classified and stored in bunches according to a classification scheme based on types of preparation, maturity, color, shine, softness, cleanliness, moisture and resistance. In Bahia, the distance from the principal production region and the port is on average 250 km; cordage and fibre are thence shipped overseas (SAGRIIR-BA, 1991).

1.2 Problems and potential solutions affecting expanded production and trade

Brazil is the principal sisal producer in the world, accounting for about 50% of the total consumption. Nearly 80% of national production is exported. The major applications of sisal are in baler and binder twine. Other parts of the leaf are used for paper manufacture, taking advantage of a 70% celulose content. However, sisal has been gradually substituted by synthetic fibres obtained from polipropylene.

There were substantial oscillations in volume of sisal produced in Brazil between 1980 and 1989, due to reductions in area harvested by producers who faced poor price terms in international markets. Productivity also fell from an average of 1,000 kg/ha in 1985 to 800 kg/ha in the period 1985-89. Minimum prices established for sisal in Brazil have been below production costs, harming the viability of investment in new plantings.

Critics suggest that the complex system of commercial intermediation in sisal is an important factor affecting its viability. Only a small part of the returns goes to the producer, who sells the leaf green in the field to owners of decortification machines. These sell in turn to fibre processors and other buyers that pass the product along down the chain. The processors sell fibre directly to exporters and twine manufacturers who sell these products overseas. In Bahia, four companies control 80% of sisal exports. Two firms completely dominate the sale of twine.

In 1975, a sisal growers' association was created, and in 1980 a small farming association (APAEB) began to focus principally on processing and direct export of sisal fibre. This entity has sought to offer better producer prices, by reducing the number of intermediaries and through fibre quality control (APAEB, 1993).

1.3 Prospects for sisal production and trade in Brazil

The decline in sisal production and productivity is rooted in structural contradictions inherent to the society and environment of semi-arid Northeast Brazil. However, several factors have had a particular impact on the irregular behaviour of production and area harvested:

- unstable market, exhibiting price oscillations that are nearly always unfavourable to producers, leading them to abandon sisal fields or cut leaves in a predatory fashion, when prices improve;

- excessively aged plantations, many between 15 and 30 years, with no apparent intent for their renewal;

- migration of the workforce as a result of low salaries and exploitative labour practices;

- lack of a systematic agricultural policy for the semi-arid region that includes technical assistance, marketing and credit (SAGRIIRA-BA, 1991).

Opportunities for strengthening of sisal activity could be achieved through actions such as those being carried forward by APAEB, and through facilitated investment credit aimed at recuperating and renewing plantations.

2. Piaçava

2.1 Product characteristics and environmental attributes

The piaçava palm (*Attalea funifera* Mart.), is a tall erect-leaved tree. Two principal species exist: *A. funifera*, that occurs on coastal lowlands in the south of Bahia, while *Leopoldina piassaba* is endemic to the Negro and Orinoco river basins in Colombia, Brazil and Venezuela. Although these are very distinct palms from a taxonomic perspective, the fibres obtained therefrom are treated as equivalent by the market.

Fibres from piaçava are used in the fabrication of brooms, naval cable, and upholstery filling. The tree's presence in the threatened Atlantic Forest of southern Bahia is an argument for its utilization as part of sustainable development strategies for this area, considered an environmental "hot spot" by Conservation International.

There are three principle growth phases in the life of piaçava: (1) "patioba", when the palm is young, stemless and producing few short fibres; (2) "bananeira", when the leaves are high, producing good fibre, but with the palm heart still underground and (3) "coqueiro", when a trunk is formed (Costa and Santos, 1985).

Fibres are located at the base of the leaf, embracing the trunk. The "bananeira" fibre is longer, owing to its longer leaves. In later stages, the leaves are angled and the fibre shorter.

Soil and climate conditions influence the period to maturity. It is estimated to require four to six years to reach the "bananeira" stage, and only two to four years later is it possible to cut fibre. It thus may require up to 10 years to enter into production in native stands.

Piaçava is not regularly planted, but even in forest growth requires cultural treatments to become more productive. The juvenile palm is subjected to thinning of short and fine fibres that would otherwise result in the palm's atrophying. Mature palm stands are generally cleaned by weeding.

Each palm produces on average 8 to 10 kg of fibre annually, during the most productive phase. The palm may be exploited for 20 years; fibre is generally cut during six months each year, but only once in each year in a given palm, since cutting more frequently results in poorer quality fibre and harms the productive longevity of the palm.

Because of damage sustained by palms during cutting, it is estimated that 5% of palms exploited suffer mortality at each harvest. The destruction of inflorescences and fruit endanger the sustainability of piaçava production.

To gather fibre, men scale ladders used to facilitate climbing the trunk. The gathered fibres are cleaned over a metal tool and afterward bound in bunches of about 60 kg (Zugaib and Costa, 1988). These are then marketed in different classes by the thickness and length of the fibre, as well as foreign matter and moisture content, defective colouration, fire and other damage. Fibres are also graded according to their flexibility and resistance.

2.2 Problems and solutions affecting expanded production and trade

Fibre has been derived from piaçava since prior to colonization for use in house thatching among indigenous groups. Naval cordage was produced in Bahia from piaçava since the sixteenth century.

Over the last 30 years, piaçava fibres have begun to be used in other regions of Brazil (Johnson, 1987). Piaçava output increased substantially from 1973-80, during which period production tripled, accompanied by a decline in domestic prices. The volume of fibre extracted is superior to 67 thousand tons per year; despite its low value per unit volume, the industry is quite significant in localities where processing occurs, as well as in terms of value added. The value of fibres marketed in 1988 was estimated at US$ 245 million by IBGE (May, 1994). Output grew gradually throughout the 1970s and 1980s from 50 to 68 thousand tons per year.

Exports have been limited to about 5% of production, due to substitution of natural by synthetic fibres in overseas markets, Total value of exports in this sector have declined from US$ 1 million in 1987 to $0.26 million in 1994. This behavior accompanied a decline in volume shipped to overseas markets, dropping from 756 tons in 1987 to 136 tons in 1994. Exports went principally to Germany, Portugal and the United Kingdom (CACEX/DTIC/CEDIV). The market is concentrated in the hands of six firms that controlled 94% of exports in 1987.

Selection and classification of fibres aims to separate long fibres from short; the former are preferred in the international market, while the domestic broom market buys the latter. Such industries located near the production area are rudimentary craft shops. Large broom industries are based in São Paulo and Rio de Janeiro. Exports are shipped from Ilheus, Salvador and Manaus (Costa and Santos, 1985).

Producers receive on the order of 15% of export price for the product. At present no cooperatives exist to market piaçava fibre. The only infrastructure required in this market is storage, so that it would not be an expensive proposition to organize marketing (Costa and Santos, 1985).

2.3 Piaçava development prospects

Farmers in the area of piaçava occurrence have been discouraged from expanding production, due to the decline in prices, that has led to substitution of piaçava stands with other land uses, such as ranching, subsistence crops and even tourist establishments near the coast. CEPLAC, the technical assistance institution active in the cocoa zone of southern Bahia, has sought to introduce cultivated varieties of piaçava to stave off further decline.

Historically, markets for piaçava fibre have been nearly completely domestic and its uses restricted to low-priced cleaning materials and mats. Exports have declined even further in recent years. It appears, unless new market niches are discovered, that further decline in production may be anticipated in the future. Although piaçava is a natural extractive product, its management has not as yet appealed to those concerned with tropical forest conservation in the way of products such as Brazil nuts or vegetal leather. Piaçava should be considered part of the diversified sustainable systems for management and protection of the severely threatened Atlantic Forest of southern Bahia.

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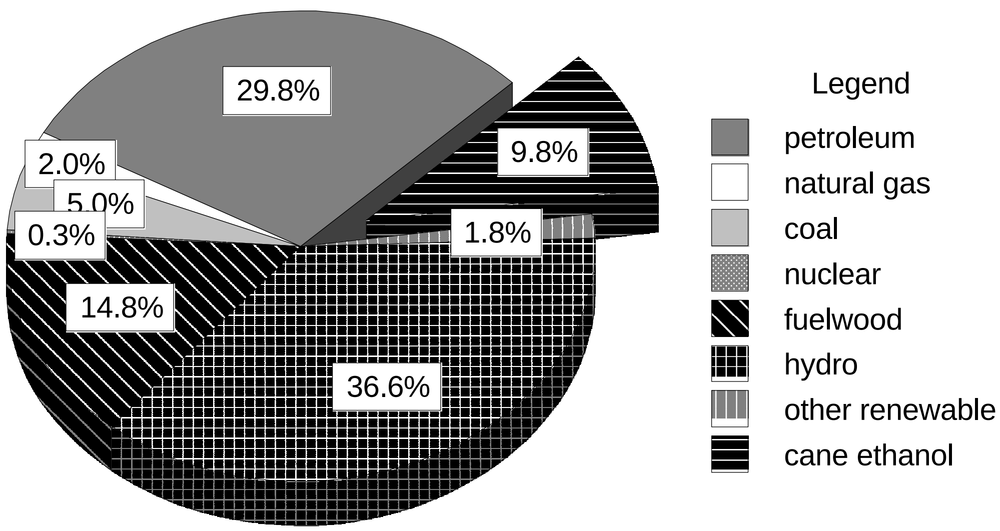
V. Sugarcane biomass

Brazil is one of the few countries in the world that, due to its extensive land mass and fertile soils, has been able to embark on a significant substitution of petroleum-based fuels with renewable biomass sources. Beginning in the mid-1970s, in response to the first petroleum price shock, the then military government initiated the National Alcohol Program - ProÁlcool. Further efforts were initiated in this period to consider the prospects for substitution of diesel and fuel oil with vegetable oil derivatives and, more recently, pilot biomass gasification plants have been inaugurated for electricity generation. However, it is ProÁlcool which has to date experienced the most far-reaching effects, having stimulated a dramatic expansion in sugarcane planting and distilling that increased national fuel ethanol production from a level of about 150 million litres in 1976/77 to an annual average of 12 billion litres in the 1985-1994 period. This output now provides just short of 10% of national energy requirements from all sources, and nearly one quarter of that derived from liquid fuels, in terms of petroleum equivalent energy (fig. 1).

ProÁlcool was created in response to several demands: first, a strategic concern for energy independence and curtailment of the foreign exchange drain that was inherent in an economy dependent at that time for 80% of its gasoline requirements on imported petroleum. Secondly, comparative advantages evidenced in Brazil's natural resource endowments would permit devotion of a significant area to biomass fuel production. Thirdly, declining international prices for sugar made attractive an expansion in domestic demand for cane-based ethanol. Finally, it was hoped that this expanded demand would help to balance regional economic disparities, to the extent that sugarcane

Figure 1. Energy Matrix of Brazil 1990



Adapted from Borges and Moura Campos (1992) and other ethanol feedstocks such as cassava could be produced in the depressed Northeast region. A related subliminal development objective was to maintain growth in the automotive industry, that could have been affected by restrictions in availability of low-cost fuel.

During an initial phase, the implementation of the programme called for annexation of distillation capacity to existing sugar refineries to enable all gasoline to receive a 22% anhydrous ethanol constituent. This composition was practicable without requiring adjustment in automobile motors, and required a five-fold increase in cane production and ethanol distillation capacity. In a second phase, auto manufacturers were mandated to redesign carburation and exhaust systems to enable vehicles to operate on pure hydrated ethanol fuel (which has a 0.5% water content). At the same time, quotas for production of pure alcohol cars increased the annual production of such vehicles from 283,000 in 1980 to nearly 700,000 in 1986, boosting their proportion of the national fleet to nearly 50%. This demand was also strengthened by the application of a subsidy to both alcohol cars and the alcohol itself, so that consumers were stimulated to opt for such vehicles. Such subsidies were financed through taxes levied on gasoline. Ethanol production shot up to the twelve billion litre level by the 1985/86 harvest, resulting in the need to install a number of distilleries destined only for ethanol (Ometto, 1994).

In recent years, expanded output of petroleum from Brazilian wells and declining world prices have made it necessary to rethink the strategic convenience of maintaining such growth in alcohol production. This thinking grew out of debate over both the production cost and energy efficiency of ethanol production. Cane production and refining costs were considerably higher than those required to pump and refine an equivalent energy supply based on petroleum, while ethanol prices were maintained at a mileage-based parity with gasoline at the pump. Although prices of all fuels were constrained below cost as a means to provide an illusion of slower monetary inflation, real ethanol production costs were actually cut nearly in half through technological advances in the period 1976-1994. This enabled the relative energy efficiency of its production to improve over time, at least in the more advanced agroindustries of Southeast Brazil.

Despite these improvements, declining petroleum import prices and an increase of domestic production to 80% of national needs has caused ethanol production to stabilize and even decline in some years, provoking crises of supply that made it necessary to import the more volatile methanol to supplement domestic production. Although the industry tends to blame shortfalls on a stagnation in sugarcane planting, the fact is that government is emitting signals that lead both producers and consumers to question the longevity of ProÁlcool. Such a reaction has dampened demand for alcohol cars so that in 1994 only 4% of all cars produced were adapted to run on pure alcohol.

1. Positive environmental benefits

Although not initially objectives of ProÁlcool, socio-environmental benefits from substitution of gasoline by ethanol have become a principal means used to counter criticism of the subsidies necessary to maintain production levels adequate to supply internal demand. The principal sources of such benefits include: agroindustrial employment, energy cogeneration and vehicle emissions reduction, that besides improving urban health conditions could help in combating the threat of global warming.

Employment in the sugar/ethanol complex is significant, particularly in the field phase, where manual labour is predominant; in São Paulo alone the sector is estimated to account for 290,000 permanent and seasonal jobs, of which 60% are unspecialized. The labour force in cane production is organized and fairly well remunerated, when compared with other rural workers in Brazil. Job creation has been shown to have a relatively low cost relative to that in other sectors (Borges, 1992).

Channelling of cane bagasse as a biomass feedstock for energy production at the plant has been a fairly common practice in sugar and ethanol production since the turn of the century. Of late, however, the potential for utilization of excess bagasse for electrical cogeneration has become widely perceived as an option, thus providing returns to the industry that can cut ethanol costs to the consumer as well as provide cheaper electricity. Market valuation of bagasse is equivalent to that paid for sugarcane, generating potential returns from sales of excess fuel of up to 25% of the cane cost. Furthermore, bagasse availability during the cane harvest (May to November) coincides with the period of low hydroelectric generation potential due to lack of rain. Limiting factors against broader use of bagasse for this and other purposes are its excessive moisture content and low energy content in comparison with other fuels. These limitations can be overcome through drying and gasification techniques, already being tested (Cortez et al., 1992). Bagasse gasification and electrical generation using condensing extraction steam turbine technology is considered a cost-effective means for supplying a considerable share of Brazil's electrical needs (Zylbersztajn and Coelho, 1992). In terms of caloric potential, bagasse is considerably cheaper than alternative fuels, making it an attractive source if such technologies become functional.

The principal São Paulo energy distributor recently entered into long-term contracts with several distilleries for cogeneration purposes, which has stimulated them to invest in expanded turbine capacity. Current electrical tariffs for cogenerators are considered insufficiently attractive to broaden this market. It is anticipated, however, that the disappearance of alternative sources of electrical generation will shortly force the government to offer tariff and financing incentives for these enterprises. This process is also expected to receive a shot in the arm from current plans to privatize the energy sector in Brazil.

By far the most significant environmental benefit actually realized, however, is that obtained by net reductions in emission of greenhouse gases and of urban atmospheric pollutants from automobiles. Net CO_2 emissions from 1990/91 sugar and ethanol production in Brazil are estimated to be significantly below those anticipated had alcohol not substituted gasoline, and had bagasse not been available to the food and chemical industries as a substitute for fuel oil (see table 4). Furthermore, automotive emissions in major urban centres were favourably affected by the conversion to pure ethanol; up to 75% reduction in carbon monoxide, 30% in hydrocarbons and 32% in nitrous oxides are registered when gasohol is replaced by pure ethanol in internal combustion motors (CETESB, 1990).

2. Problems of expanded production

The sheer audacity of the programme brought worldwide attention to ProÁlcool, subjecting it to intense examination of negative effects provoked during the period of its implementation.

Drawbacks to the massive expansion in ethanol production were inherent in the serious environmental repercussions that ran along the ethanol production chain from field to final distribution.These include the substitution of prime agricultural land otherwise used for food production, gas and particulate emissions from cane burning in areas proximate to settlements, and the deposition to waterways of large volumes of distillate effluents, whose oxygen demand imperilled aquatic biota and potable supplies.

Table 4. Net CO_2 Emissions from Brazilian sugarcane agroindustry (1990/91 harvest)

Emission Source	*Million tons of carbon per year*
Substitution of gasoline by alcohol	−7.41
Substitution of fuel oil by bagasse	−3.24
Use of fossil fuels in cane agroindustry	+1.20
Net contribution	**−9.45**

In some municipalities in the state of São Paulo, which was responsible for 64% of cane production for ethanol in 1990, as much as 75% of total land area is occupied by sugarcane destined for distilling. The substitution of arable lands and forests by cane to feed ethanol demand is one contributor to serious soil erosion problems registered in these areas (Guarneri and Januzzi, 1992). Cane burning carried out to facilitate manual cutting has been found to increase levels of ozone and carbon monoxide well above baseline indices (Kirchhoff et al., 1991). Particulate pollution and damage to electrical transmission lines pose additonal risks.

At the distillery level, effluents generated through industrial processing produce a biochemical oxygen demand (BOD) of 8.7 kg t^{-1} of cane feedstock. The liquor (*vinhoto*) arising from distillation constitutes 67% of this load. Although distilleries had been prohibited by law since 1980 to discharge these effluents directly to streams, even in the relatively advanced state of São Paulo, it is estimated that up to 37% of the volume generated is still discharged in this fashion (COPERSUCAR, 1989), although very little of this is discharged without treatment of any kind. In the state of Minas Gerais, on the other hand, one study found that nearly 70% of untreated industrial Biological Oxygen Demand (BOD) discharges originated in 31 sugar/alcohol enterprises (Mendes, 1994). The alternative to treatment and discharge is to utilize the liquor as a fertilizer which has the added advantage of increasing cane production by up to 30%. But here potential problems may arise due to excessive application, a potential cause of salinization and contamination of groundwater.

There is clearly substantial retrofitting needed in many distilleries, particularly in the Northeast and Minas Gerais. To finance such technology, low-interest guaranteed loans are available from the national development bank. There is also a need to intensify the rather lenient pollution control policy prevalent in the sugar and alcohol industry.

3. Prospects of ethanol trade for environmental improvement

Ethanol exports from Brazil were registered in the period pre-1991, but ceased when domestic shortfalls made this undesirable. The recent decline in domestic demand for alcohol cars has led some to consider the prospect that a portion of Brazil's ethanol production could be exported as a fuel additive for Northern nations that are seeking means to control automotive emissions. The United States has subsidized production of ethanol for this purpose, for example, reducing domestic ethanol costs for gasohol to 50% of Brazilian production costs (Ometto, 1994). Such a measure may however be more directed towards resolving the oversupply of Midwest maize than geared to satisfy environmental objectives, and trade may arguably be a more rational approach toward internalization.

For ethanol trade to become viable would require that current subsidies of the kind reported here be removed. It would also be necessary that domestic demand be satisfied first. Should the current trend to reduce production of alcohol-based vehicles continue, it is possible that ethanol producers will face an oversupply problem that could be overcome by trade.

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VI. Urucum

1. Product characteristics and environmental attributes

Urucum, also known as urucú and annatto (*Bixa orellana* L.) is a shrub of 2 to 6 m in height, whose origin is Latin American, but is now found cultivated throughout the tropics. Latin American producers include Peru, Colómbia and Ecuador as well as Brazil (Mello and Lima, 1991). The seeds of the urucum flower, that take the form of 15 to 20 bristly purse-shaped red capsules containing from 30 to 60 seeds per capsule, have been used from time immemorial as a colourant by Indians who paint their skin with its red dye for ornamentation and also as an insect repellant. Today, urucum is one of the major global sources of natural red dye and colorant, composed principally of carotene compounds. After having been supplanted since the Second World War by Red Dye No. 3, prized for its low cost and stability in fluids, the discovery of carcinogenic properties in this synthetic dye led the U.S. Food and Drugs Administration to ban its use; the European Union also plans its prohibition. This ban has stimulated renewed interest in urucum among growers, food processors and cosmetics firms (Smith et al., 1992).

Urucum is an attractive perennial crop in that it begins to fruit in the second year after planting, with commercial production being initiated in the third year, and a useful life of 30 years. The adult bush produces from four to five kilogrammes of seed each year; depending on spacing (the average in use is 500 plants/ha), production from 1,100 to 2,300 kg/ha/year could be attained. Plants are begun in a nursery from seed, and transplanted three months afterward. The only significant management required is to prune branches so as to stimulate flowering.

Despite the fact that urucum is widely cultivated today, there is very little systematic research on its improvement as a crop; those plants grown today were propagated from directly sown seed, or from seedlings. The principal characteristics that are desirable for crop development are plant productivity, principally related to the number of seeds it produces, but also to the bixine content of the seeds, an expression of its colourant content (EMATER-MG, 1984). Both seed number and bixine content vary considerably in harvested plants, due to genetic variability. Market acceptance requires that seed contain 2.5% bixine, but many cultivated varieties are found with only 1.6 to 2.1% (Abel Rebouças, pers. comm.).

Harvest and storage are manual activities, conducted immediately after flowers reach maturity. There are two harvests each year, one of which is two months in length, and the other, smaller, of one-month's duration. Capsules are left to dry and afterward beaten to remove the seeds. This latter process has been partially mechanized, and the separation effectuated with a blower. Seeds are handled in 50-kg sacks, stored in dry, well-ventilated facilities (EMATER-MG, 1984).

Urucum is sold either in the form of seed or "*colorau*" powder, added directly to foods as a colourant. From the seeds, bixine pigment is extracted for use in the cosmetics and food products industry. The range of bixine found in seeds ranges from 1 to 4%, as compared to the level of at least 2.5% considered desirable by the industry.

To obtain colourant, producers in the past immersed the seeds in hot water; after evaporation, the paste was sold wrapped in banana leaves. More recently, processes have been developed to dissolve bixine pigment that involve the use of organic solvents such as chloroform, acetone, propilenoglicol and ethanol; residues of these processes may be toxic, inhibiting their use in food colourants. Such methods make it possible to obtain a solid product containing bixine in concentrations from 10 to 50%. Other methods involve dissolving bixine by heating in vegetable oils, since the colourant is liposoluble. The resulting product is marketed in the form of an oil solution at varying concentrations. Finally, purely mechanical processes are employed that grind the seed to remove the external layer by friction; the resulting powder is marketed directly as a food additive. A treatment in alkaline solution for pigment extraction transforms bixine in norbixate, soluble in water, which broadens the spectrum of possible applications (Carvalho, 1989).

2. Expansion in urucum production and trade

Urucum has been cultivated in Brazil for many years, where the crop is found in the Amazon states of Acre, Amazonas and Pará, in the Northeast states of Bahia, Ceará, Paraíba and Piauí, and is also grown in Rio de Janeiro and São Paulo. In 1991, the 8,000 to 9,000 tons of seed produced were destined principally for the domestic market, for fabrication of colourants.

However, there has been a rapid growth in exports over the 1985-94 period. In 1985, only 1.8 tons were exported, a figure that jumped to 840 tons in 1987 and by 1994 had reached 2,504 tons (CACEX). In the latter year, the registered free-on-board value of these exports was US$ 5.6 million, consolidating a product that until shortly before had been completely insignificant in Brazilian trade.

There is considerable expectation that Brazil can become a major exporter of bixine in the coming years, given the growing trend to ban synthetic dyes and colorants in the industrialized nations. Currenly, the principal importers of urucum seed are the United States, France, the UK, Venezuela and Japan (Mello and Lima, 1989).

The Brazilian market is composed of 15 industries of medium and large scale, distributed throughout the country. Among these, there is clear division between producers of colourants and dyes. There are nine types of colorants being produced for the domestic market for both food and industrial purposes, most of which is consumed in fabrication of pasta and fillings.

The structure of Brazilian urucum commerce, of approximately 7,000 tons per year, according to Ghiraldini (1991) is made up of the following components:

- 1,000 tons in concentrated pigment extracts with 20 to 30% of bixine or norbixine content, sold preferentially on the foreign market; about one third of this output is sold in the form of seed for processing overseas;

- 2,000 tons in colourants, most of which are water soluble, sold in liquid form with a 0.5% norbixine content; oil-soluble colourants with bixine as principal active ingredient sold in solution and partially in powder form to a market between 300 and 500 tons per year. When sold for use in pastes, these formulations include beta-carotene and/or curcumine extract. Bixine content in the latter ranges from 0.2 to 0.7%.

- The remaining 4000 tons of seed are used for fabrication of colourings or *colorau* powder. Urucum seed constitutes from 14 to 20% of these preparations; this market is made up of 20 to 25,000 tons of food additives.

3. Prospects and problems for product development

Perspectives for development of urucum products are favorable. The United Nations Food and Agricultural Organization has established restrictions towards use of artifical food colourings in foodstuffs, principally affecting those derived from petroleum, a measure that is anticipated to enhance demand for natural colourings. In Brazil as well, studies have concluded the desirability to prohibit such compounds, still used in fabrication of candies, liqueurs, jellies and cheese.

Urucum possesses other favourable properties that make it a desirable substitute for synthetics. Norbixine is the only natural pigment that reacts with caseine, making it exclusive in this segment for use in cheese and milk. Fast food and confectionaries are also promising markets. Some researchers suggest that the product has antioxidant and cancer preventive qualities, but these claims have yet to be proven. Multinational firms have invested considerable sums in the improvement of seed quality and in pigment extraction technology in Brazil (Lima, 1991).

A recent development is the organization of producer groups among indigenous nations in the Amazon region, using urucum as one local product supplied to Northern consumers that can generate income and stimulate Indians to manage and protect their natural resource base. The cosmetics company Aveda, based in Minneapolis, MN, U.S.A., has contracted a resource specialist and sustainable development project manager who has organized local urucum production groups among the Yawanawa tribe in the western Amazon state of Acre. A small portion of the seed produced by the Indians is used by Aveda in manufacture of an "urukú®" line of "totally natural lip colours" whose pigments are named after the scientific and Spanish names for urucum (bixa, orellana and annatto), and which also use babaçu oil (see chapter XII) as a vehicle. Aveda stresses the seed's tribal origin, its organic production and potential for protecting rainforests in marketing these lipsticks.[2]

Research is needed to overcome persistent bottlenecks in urucum production, including particularly the low bixine content in Brazilian seed, which seriously impairs market penetration (Mello and Lima, 1989). Research should focus on more productive varieties and more efficient industrial processes, seed classification mechanisms and norms for product quality, including identification, quality, appearance and packaging. Excessive moisture content that attracts mold, the presence of foreign matter, deformed seed and impurities, and the lack of an appropriate method for bixine analysis have been mentioned as immediate problems requiring action to improve product competitiveness (Mello and Lima, 1989; Rasera, 1991). It is encouraging that Brazilian growers have formed an Association of Producers of Natural Colorants, that has met in annual seminars to discuss means to overcome some of the issues facing the industry.

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VII. Erva-mate

1. Product characteristics and environmental attributes

A tonic stimulant, herbal tea (*erva-mate* or *yerba té* in Spanish) remains one of the most popular beverages consumed in the Southern Cone; its enjoyment among those who share the "*cuia*" or drinking gourd has been deeply imbedded in local custom since the time of the Incas. The importance of its production served as principal argument for the political emancipation of Paraná state in southern Brazil in 1853.

Erva-mate occurs throughout the principal states of southern Brazil, also being found to the west in Mato Grosso do Sul, the Misiones Province in Argentina, and eastern Paraguay. The species *Ilex paraguayensis* grows spontaneously in association with Araucária pine and subtropical forests of southern Brazil, in an area of occurrence of about 540 thousand km^2.

Erva-mate yielding species belonging to the genus *Ilex* native to Brazil are today widely cultivated. These shade-loving plants resemble orange trees in size, generally not reaching over seven metres in height when pruned to remove the valuable tea leaves. Their management in watershed catchments and planting into agroforestry systems makes them an important part of the regional farm economy and provides significant environmental benefit. Annual production in Brazil is on the order of 145,000 tons, with a final market value of US$ 200 million. Exports constitute a minor share of total output, and most of this goes to neighboring Uruguay.

Besides its traditional consumption as a hot beverage, sipped through a silver filtering straw, erva-mate is also taken as a tea infusion, either warm or cold, by a large proportion of the regional population in the Southern Cone. It is also increasingly exported to natural and health food retailers in the U.S., Europe and Japan. Among the tea's purported medicinal properties, erva-mate boasts characteristics as a stimulant (caffeine), diuretic and digestive aid. In addition, the tea offers high nutritional value, containing beta-carotene (vitamin A), vitamins B1 and B2, and vitamin C.

When planted as part of reforestation projects, in agroforestry systems or monocrops, erva-mate trees act as an agent for soil recovery. Nevertheless, due to the intensive utilization of both leaves and fine twigs as tea infusions, erva-mate is perceived as a crop and is managed as such, having received considerable attention from research directed towards management techniques that have improved its profitability. The conjunction of features of environmental protection with good financial return make erva-mate a valuable product to augment small farm-income generation in sustainable agroecosystems.

Agroforestry systems involving native erva-mate species are formed when clearing for cultivation by retaining trees in their natural wide and uneven spacing over annual crops in a mixed cropping system. Such systems, which typically include subsistence cultivation of maize, cassava, beans and rice, require minimal soil preparation and low use of inputs or mechanization. The annual crops act as the principal land use, and erva-mate constitutes a supplementary flexible source of income, also acting in a beneficial way to protect the soil from erosion due to rainfall and wind action. Stands of erva-mate in native forests also shade natural pastures for cattle, goats and sheep, which control growth of undesirable species, and do not harm the productivity of erva-mate.

More intensive production agroforestry systems have been devised, with regular tree spacing on graded and plowed lands over annual crops, principally maize and soybeans. Erva-mate seedlings are planted in spacings of 1.5 m within rows. Density of row distance is determined by the combination crop, but a 4 metre distance has been found optimal. These systems, with high nutrient use and insect control aimed at the annual crop component, achieve output similar to that found in monocrops, with additional income derived from erva-mate harvest beginning in the fourth year after planting. Combinations of erva-mate with multipurpose and nitrogen-fixing tree species in such plantings has also been found beneficial.

Although minimal inputs are required to assure productivity of erva-mate, recommendations for the more intensive systems include application of up to 250 kg of NPK fertilizers/ha and about 100 g of urea for each seedling beginning in the third year after planting, to compensate for export of leaves. Pruning to form a generous crown occurs during the first three years, followed by production cutting, beginning in the fourth or fifth year after planting. Average productivity of 14 to 20 kg/tree is attained after 10 to 12 years in intensive systems. The systems based on intercropping within native stands involve less frequent pruning, offering yields between 80 and 180 kg of leaves per tree every 3 to 5 years.

Other cultural treatments include the cutting of grassy undergrowth during maturation of seedlings up to the third to fifth year after planting, to minimize competition. Pest control recommendations suggest biological methods to avoid the transmission of chemicals to the leaves. Such methods include introduction of natural predators, manual removal of insects, crown pruning, cutting and burning of infested branches.

The net income generated by erva-mate producers varies with the planting patterns, inputs and cropping intensities adopted. These have been divided into three systems characterized, respectively as: (1) extractivist; (2) non-technical; and (3) technical. The basic differences among systems are summarized in table 5, demonstrating greater intensity of planting, labour requirements and output.

Table 5. Erva-mate production systems

	Extractivist (1)	*Non-Technical (2)*	*Technical (2)*
Trees/ha	250	835	1,666
Labour requirement (3)	56	64	122
Output (kg/ha/year)	8,750	10,020	24,990
Output value (4)	$385	$442	$1,102
Cost (US$/ha)	$160	$304	$620
Net income (US$/ha)	$225	$138	$482

Notes:
(1) Biennial pruning; farm,s average 10 ha inerva-mate.
(2) Animal traction; biennial pruning; farms average 16 ha in erva-mate
(3) Man-days/ha/year inharvest years
(4) Erva-mate prices placed at the industrial processor average of US$ 0.20/kg. Estimate asssumes 60% weight loss after harvesting and 20% transport costs.

Source: EMATER-PR (1993)

In general, erva-mate is perceived as a fairly lucrative crop, once mature, particularly in low-input extractive systems. The majority of costs are due to management, requiring considerable surplus labour, not always available on the small farm. It must be borne in mind that those systems which depend on planted erva-mate require up to five years of management and seedling protection before production begins, and only in the tenth or twelfth year do they attain production levels such as those described in the table; furthermore, harvesting is only possible on a biennial or even triennial basis in planted systems, and only in three- to five-year intervals in extractive systems.

Despite its regional economic importance, the processing industry based on erva-mate is still rather rudimentary in sophistication and level of organization. While growers organize initial processing and marketing through municipal cooperatives, the secondary processing industry based on erva-mate is fragmented sub-regionally and has not modernized to adapt to more demanding quality parameters.

Initial processing at the producer level involves cutting, drying and threshing, called "*cancheamento"*. The leaves are heated by exposure to fire to remove part of their moisture content, but avoiding that they blacken. Further drying is accomplished in a subsoil kiln. Finally, the leaves are threshed in the "*cancha"*, a process that has been broadly mechanized.

Quality parameters for erva-mate are based on colour, flavour and aroma. Bright green leaves are preferred that, after six months of storage, turn to a yellow-silver colour. It is the smooth flavour of the infusion that determines erva-mate's quality, avoiding bitter or sour flavours. A good erva-mate is one that can be infused with boiling water up to 15 times without losing its flavour and aroma; lesser teas lose their flavour after five infusions.

2. Problems and solutions for expanded production and trade

In 1992, there were 409 Brazilian companies engaged in secondary processing of erva-mate, classified in three groups for fiscal purposes, as "macro", "large" and "micro". These firms classify, cure and package preprocessed leaves for market. The 13 largest (macro) firms are responsible for 70% of Brazilian exports, and are fairly lucrative financially. Micro and large firms are lower ranked in terms of the prices received, owing to poorer product quality. A recent analysis suggests that the latter firms did not operate at a profit based on prices prevalent in 1993 (EMATER-PR, 1993).

The domestic market for erva-mate relies on traditional knowledge of the product, with little emphasis on variable chemical composition, medicinal properties or types of beverages that might be derived. This market is still strongly centred in southern Brazil, with a large part going to Rio Grande do Sul, which purchased 60% of the total domestic consumption of 117 thousand tons in 1990 (according to "setor ervateiro"); Paraná, which currently exceeds Rio Grande's production, was the second largest consumer (17%), and Santa Catarina the third (13%). The remainder was shipped to other states in Brazil such as Rondônia, where many migrants from the south have settled. Sectoral interests believe that domestic market potential can be considerable, if a promotional effort is made to emphasize the range of uses of the infusion (as a refreshing iced tea, for example).

The overseas market for erva-mate has been concentrated during the period 1980-91 in Uruguay, which consumed between 5 and 18% of the total Brazilian output over this period, or nearly 90% on average of total exports. Chile, Germany, North America and Japan are also importers. Brazil itself also imports a small amount (averaging 2,400 tons per year) from Argentina when there is a domestic shortfall.

A further concern that faces the erva-mate industry is the need to improve production technology, substituting native trees with plantations and regularizing the periodicity and practices employed in pruning. If this does not occur, there is some fear that, with the removal of trade barriers within MERCOSUR, Argentine erva-mate will outperform the Brazilian product in the domestic market.

3. Prospects for product expansion

Prospects for erva-mate suggest that the domestic market offers greater potential for expansion, due to the difficulty in achieving quality characteristics that would enable the product to be offered widely in more discerning markets. Among such characteristics, processors perceive, is the environmentally protective features of its production systems. There is also concern with product adulteration, which is a fairly generalized practice to increase volume.

Future market prospects include the chemical industry, where erva-mate has begun to show promise for use in paints, resins, medicines, disinfectants, etc., although this use suffers competition from alternative sources. The same is true with iced teas, which face competition from the large range of fruit juices that enter the Brazilian market

In general, the potential for both domestic and foreign market expansion in erva-mate are conditioned on a policy of expansion of plantings and investments in modern environmental and commercial practices.

VIII. Cupuaçu

1. Product characteristics and environmental attributes

The cupuaçu tree (*Theobroma grandiflorum),* a plant relative of cocoa, produces a fruit whose pulp is prized in the Amazon basin for juices, jellies, ice cream and liqueur; its seeds can be used as the base for a white chocolate. Having its origin in native forest, cupuaçu is representative of the growing pantheon of non-timber forest products, leading to it to be considered among those resources that will help to ensure conservation of tropical forests. However, cupuaçu is increasingly produced in small farm agroforestry systems as a cultivated perennial crop species. Not requiring significant use of chemical inputs, this natural product is increasingly demanded by southern Brazilian consumers, and frozen samples have been exported to explore use in ice creams.

The cupuaçu tree in its native state grows higher than 20 m but when cultivated reaches only 6 to 8 metres. Its fruit have a rust-coloured tawny peel, and are cylindrical in shape, of 10 to 12 cm in diameter, weighing on average 1.5 kg.

Most fruit are harvested from the wild, but there have been rapidly expanding plantations of cupuaçu in the understory of fallow secondary growth or in native forest, as well as in agroforestry combinations with other forest species or with the cabbage palm *pupunha* (see section on palmito). Cupuaçu is well adapted to shade, particularly in juvenile stages. There is no information available on the area planted to cupuaçu in this way, but informal research by the industry suggests that one or two million trees may have been planted over the past ten years.

Cultivation techniques for cupuaçu are still being perfected. There are as yet no improved seed sources; rather, producers select seed from the fruit gathered from adult wild individuals that are healthy and present high productivity. Seedlings are produced not only from seed but also by grafting. Plantings are made at five metres distance. Cupuaçu flowers and bears fruit between November and March; the first flowering occurs in the third year after planting.

Pesticide use has not been significant even in dense plantations, due to only minor insect predation; cupuaçu has coevolved with a number of natural predators. Witch's broom is present in most cupuaçu areas, although attacks are reduced among individual trees scattered in the forest. Some natural resistence has been found, but management is the only means to combat this disease at present, involving the cutting and burning of infested branches. Only organic fertilizers are employed.

On average, mature cupuaçu trees produce 45 fruit annually, varying with water availability and soil fertility. Cultivated stands have an output of 400 fruit/ha on initial bearing, and 9,000 fruit/ha by the tenth year, yielding about five tons of pulp.

Processing of cupuaçu fruit for pulp is fairly simple, involving breaking open the fruit and removing the pulp by manual or mechanical depulping of the seed. The pulp so obtained is frozen; storage in this form being practicable for up to one year without significant alteration in product quality characteristics (Ferreira, 1994). Quick freezing at low temperatures has been found to be desirable to maintain the pulp's appearance. The pulp constitutes about 35% of the fruit by weight; the remainder is made up of husk (45%) and seed (20%). The husks are used as a mulch. Seed are in part used for propagation, and some tests have been made of use in chocolate manufacture. The pulp is high in pectin, and contains some vitamin C (about 2.15% is composed of citric acid).

In fruit gathering and pulping, intense use is made of female labour, as well as that of children. Manual techniques that use a scissor are preferred for certain applications such as sweets and jellies, for which small pieces are desired. The mechanical method produces a fine homogeneous pulp that is used in making ice cream, juices and nectar. There are no serious environmental hazards resulting from small-scale pulping processes of this kind, although quick freezing requires substantial electric power.

2. Problems in expanding markets for cupuaçu pulp

Production of cupuaçu is concentrated in the Eastern Amazon, although there has been a major expansion in planting throughout the Amazon basin, by small-scale family farmers. These growers are generally quite distant from consumers, even those located in the Amazon region itself. The fruit are transported in small trucks or boats to the principal regional capitals in distances ranging from 20 to 300 km. Frozen pulp is hauled in refrigerated trucks to the markets of the Centre-South.

In the beginning of the 1990s, small farm organizations began to proliferate in the Amazon region, fomenting cultivation and marketing of perennial crops, including cupuaçu. Cooperatives have emerged that seek to market pulp in the developed parts of Brazil and overseas, through contact with Japanese and Swedish buyers. In Brazil, marketing has focused on supermarket chains, restaurants and juice bars.

Due to its unique flavor and popularity among Brazilian consumers, cupuaçu pulp now occupies a privileged position, despite fairly high prices. On the other hand, it is possible that the producer response to this growing demand may have been excessive, which may lead to a depressed market when new plantings begin to bear fruit over the next few years.

The regional capacity to produce and store cupuaçu pulp is extremely limited, and it is not clear that the sector is developing the necessary infrastructure to handle the anticipated production. At the same time, national and international buyers are demanding lots that are signficantly larger than local markets are able to provide. The segmentation of the markets into bulk (export, supermarket) and smaller purchasers (luncheonettes) requires agility in provision of variable packaging sizes (MacGrath, 1995).

Cupuaçu pulp is very sensitive to hygiene and to the use of water in mixture that can harm the quality of the pulp when frozen. International markets insist on 100% pure pulp. In chocolate formulations, cupuaçu's melting point is higher than that of cocoa, which makes it improbable for use in candy bars, although confectionary applications are an immediate prospect.

3. Development prospects

Cupuaçu planting has come to be perceived as a promising agricultural opportunity for the Amazon, leading to an accelerated rate of expansion in planting area, even if only in small units. The characteristics of its cultivation in forest understory and agroforestry systems, can act as an important incentive to conserve forest resources, thus offering an environmental rationale for expanded output.

It is still somewhat unclear how consumers may respond to a major growth in supply. If it becomes possible to supply pulp more cheaply, the base of the market may expand evenly with supply (MacGrath, 1995); on the other hand, a flooded market that reduces prices may make production unviable. Lack of infrastructure to handle consumer demand is also a drawback that can weaken future market prospects.

Since cupuaçu production is linked with producer associations and cooperatives, it may be possible to establish direct commercial links between these and both domestic and foreign wholesalers. A price premium to such organizations based on the environmental features of production (organic agroforestry practices under native tropical forests, avoiding felling to establish plantations, for example) could assist such groups assure their capacity to produce and store cupuaçu pulp in volume and quality to match the growing market demand.

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IX. Cashew nut

1. Product characteristics and environmental attributes

Cashew (*Anacardium occidentalis*), a tree of up to 20 m in height native to the semi-arid tropics of the northeast coast of Brazil, was domesticated by indigenous peoples and widely disseminated as far as the West Indies prior to conquest. International commerce in cashew nuts began in the early 20th century; today Brazil and India are the major producers (Smith et al., 1992). Brazil exported 38 thousand tons of cashews in 1992, the peak year. A hard, dry appendage, the nut is the true fruit of the species, while the "pseudofruit", a succulent and fibrous "apple", is a by-product, used in the fabrication of juices and confectioneries.

The cashew is a multipurpose tree suited to poor laterite or sandy soils. As such, it can be planted in degraded areas and is recommended for rehabilitating poorly managed pastures or in shifting cultivation areas where fallow periods have been reduced due to population pressure. Cashew tolerates drought and high temperatures but not cold or poorly drained sites. This feature makes cashew production viable for production on semi-arid lands that are marginal for other crops. It is particularly valuable as a component in northeast Brazilian agroforestry systems, where it is intercropped on small farms with coconut, citrus, and banana as well as staple food crops such as cassava and maize. The cashew agroindustry provides cash income and both rural and urban employment that helps to stave off deprivation in drought years.

Traditional cashew plantings are accomplished with spacing of 10 x 10 m, using seedlings or direct planting of fruit. Commercial plantings do not require heavy fertilization; growers generally apply cattle manure and mineral nutrients in four-year intervals. To protect soils, reduce evaporation and assure nutrient cycling, mulches are applied during the first years after planting, employing otherwise wasted plant residues.

Although not a nutrient demanding crop, cashew is susceptible to disease and pests that attack leaves, flowers and fruit, for which research institutions have recommended application of chemical controls. However, the use of insecticides is expensive and decreases fruit set. Traditional plantings are heterogeneous which is good for disease resistance but not for consistent yields. The interplanting of several high quality clones has been found to reduce the threat of catastrophic disease and pest outbreaks.

Traditional cashew fruiting commences in the third year after planting. The harvest season is three months in duration. Adult trees produce between 100 and 150 kg of apples, corresponding to an average production of 10-15 kg of nuts per year, although estate production averages only 300 kg/ha. Maximal output is obtained in the 10th year, and the tree has a lifespan greater than 20 years. A dwarf variety has been introduced that is propagated by grafting, and begins to fruit only two years after planting, offering a higher yield and longer harvest period than traditional varieties.

Harvesting is traditionally carried out by picking fallen fruit from the ground, resulting in loss of the apple to spoilage. Dwarfing has made it possible to gather fruit prior to falling, and broader use is hence now made of both apple and nut. Pseudofruits possess high vitamin C content. They are widely marketed for direct consumption, and a juice extraction industry has grown up that produces a low cost concentrated beverage prized by Brazilian consumers. Nuts are roasted in the shell and then cracked. Oil-bath processes give a quick and uniform roasting and a higher recovery of shell oil. After cracking, the testas are removed and the nuts vacuum packed for export.

Mechanical shelling has not been successful.

Several cashew by-products are used to make industrial products. Cashew nut shell liquid (CNSL), exuded during roasting, is a phenolic substance used for waterproofing and as a preservative. After distillation and refinement, CNSL is used in varnishes, lacquers, and brake linings.

Recent research in Brazil[3] suggests the potential of cashew trees to be tapped for their resinous exudate that could substitute for gum arabic, currently imported from the Sudan after processing in Europe and the United States. The substance is used in preparation of glues, food stabilizers, and medicines. Among other advantages, the gum could be derived from trees that are no longer productive for nuts; tapping of exudate has been shown to be unharmful to adult trees.

In summary, cashew production represents an environmentally favourable option for use of marginal soils in the semi-arid tropics of Northeast Brazil, where it is grown in diversified agroforestry systems incorporating annual crops and grazing. Low use of chemical inputs or fertilizers, a fairly complete use of cashew fruits and application of residues as mulch are additional beneficial environmental attributes of cashew.

2. Problems of expanded production and trade

During the past two decades, there has been an accelerated expansion in cashew cultivation, motivated principally by fiscal incentives and high prices for nuts and derivatives in the domestic and foreign market. From 1970 to the mid 1980s, Brazilian growers planted about 200,000 ha to cashew, mostly in the Northeast (Smith et al., 1992).

Prices and returns suffered significant variability in the 1970s and 1980s, as a function of the inadequate use of modern production techniques and the presence of market imperfections arising from oligopsony power exercised by a small number of major buyers. Beginning in 1984, a large volume of nuts of Indian origin began to enter the United States market, a principal importer, forcing Brazilian growers to assume a more competitive stance. This was particularly important after the fiscal crisis forced the government to cut subsidies to the sector at the end of the 1980s (Pessoa and Lemos, 1991).

Brazil maintains a relative market share of 30 to 40% of world trade in cashew nuts, slightly below that of India, now the principal producer. Cashew nut exports from Brazil over the past ten years have fluctuated between 14 and 26 thousand tons annually, at a yearly value ranging between US$ 86 and 108 million (see fig. 2).

Exports are destined principally for the United States, responsible for about 80% of Brazilian exports. Other importers include the Low Countries and Canada. The period was marked by moderate fluctuation of cashew prices in the international market (see fig. 3). The lowest prices received, of US$ 3,750/ton free-on-board, in 1989-90, were significantly lower than the highs of 1987, when prices averaged US$ 5,805/ton. Due to its market share, Brazilian supplies have a significant role in this variability.

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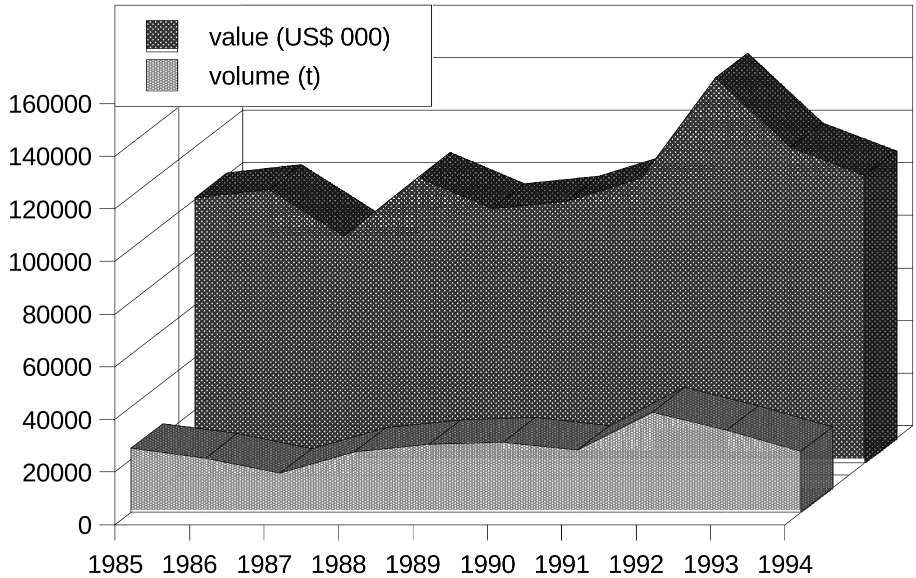
[3] Clodion Torres Bandeira, National Center for Research on Tropical Agroindustry (CNPAT/ EMBRAPA), Fortaleza.

Figure 2. Cashew Trade

1985-94

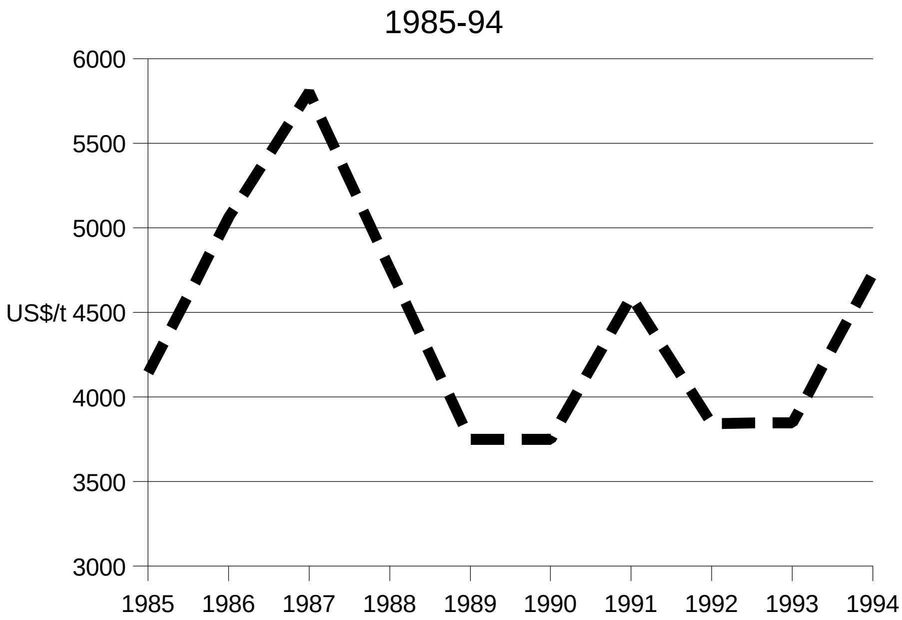


Price behaviour in cashew nut exports is owed to the fact that the product faces competition with a number of substitutes, and there is hence a high price elasticity of overseas demand. Gains from trade have principally been a result of monetary devaluation, stimulating output expansion more than have relative price improvements, and the majority of these benefits have been captured by intermediaries. More competitive markets would be beneficial to producers who could thence become more responsive to price shifts in the international market (Pessoa and Lemos,1990).

3. Prospects for product development

Brazilian cashew production already represents a significant share of international trade, and may be able to sustain this position as a result of productivity improvements arising from the more competitive market context since the late 1980s. Voracious domestic market for cashew byproducts for juice and confectionery also represents a positive asset. Environmental benefits represent positive physical externalities to this trade; efforts to enhance social benefits through producer cooperation should be stimulated.

Figure 3. Cashew Export Prices



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X. Brazil nut

1. Product characteristics and environmental attributes

The magnificent towering Brazil nut tree (*Bertholletia excelsa*) occurs widely in the Amazon basin, as well as on plateaux and lowland forested areas of the Guyanas, and in the upper Orinoco river basin. Brazil nuts are an important source of income and food to forest peoples; they are used as a substitute for coconut in cooking, and are eaten as a snack that offers a major source of protein and calories.[4] Their production is seasonally complementary with that of rubber tapping, offering the possibility for a year-long flow of income. Due to the crisis in natural rubber, Brazil nut gathering has become a principal source of cash to ensure survival of extractivist communities in the Amazon, today considered synonymous with forest conservation (Nepstad and Schwartzman, 1992). Brazil nuts generated an annual average of nearly US$ 30 million in export revenues to Brazil over the last decade, although the nation's former dominance in this trade is being eroded due to competition from neighboring Bolivia.

The Brazil nut or *castanheira* is an "emergent" tree, whose crown of up to 50 metres in height and 40 in breadth extends well above the *terra firme* upland tropical rainforests found in much of the region. Not usually found in dense stands, Brazil nuts average only one or more individuals per hectare. More dense stands were once found in southern Pará state in the eastern Amazon, where 15 to 20 mature trees were to be found per ha in stands of 1 to 15 ha in size. Speculation has it that this pattern was due to the intervention of indigenous communities that planted the trees in openings established for shifting cultivation (Clement, 1993).

A mature Brazil nut tree yields between 100 and 225 kg of nuts in the shell within a hard woody capsule that can weigh up to 2.5 kg, each containing from 10 to 25 nuts. Fruit fall from the tree during the rainy season, from November to March, and are gathered from the ground. Gatherers break open the fruit to remove the nuts, which they market in the shell. Shelled nuts receive at least double the value of those in the shell, but problems with spoilage have made it difficult for dispersed gathering communities to benefit from this price advantage. Recent efforts by extractivist cooperatives in Acre to organize shelling and packaging enterprises in decentralized units have some promise to improve local value added from this activity (see CAEX case study below).

2. Problems and possible solutions for expanded production and trade

As much as 95% of nuts produced in Brazil are destined for export. Demand for Brazil nuts in the shell has historically been greatest prior to the Christmas holidays, which implies that much of the previous season's output must be stored to benefit from this end-of-year demand, a factor that causes considerable post-harvest loss due to spoilage. The major buyers are in the United States, United Kingdom, Germany, Canada, Australia and New Zealand. Brazil exports on average 12 to 17 thousand tons in the shell and the in-shell equivalent of 20 thousand tons in the form of shelled nuts. Due to their relatively high prices, substitution by other nuts in a highly elastic market setting may affect prospects for growth in the Brazil nut market (La Fleur, 1993).

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[4] Average content is about 15% protein and 68% fat by dry weight, and about 675 calories/100 g fresh weight (based on data presented in Clement, 1993).

Besides demand limitations, the destruction of a large part of the Brazil nut stands in southern Pará has caused a significant shift in output toward the western Amazon. Prohibitive port costs and export duties from Brazil stimulated growth of production in Bolivia, which has emerged over the past few years as a leading exporter of Brazil (or perhaps Bolivia) nuts, presently supplying approximately 60% of the world market. Reportedly, many producers in Brazil's western Amazon shift their output clandestinely into Bolivia to avoid export costs.

Other factors that explain the secular decline in Brazilian production include damage from fire used periodically to control forest regeneration and enrich soils in pastures. Brazil nut trees are considered a source of one of the finer quality timbers in the Amazon, being straight grained, easily worked, of good appearance and durability (Loureiro et al., 1979). Although it is illegal to cut the tree, there exists a considerable clandestine market for its wood (Mori and Prance, 1990).

Plantations of selected and grafted varieties of Brazil nuts have been established near Manaus, promising further changes in the industry. These trees are expected to produce beginning about 8 to 10 years after planting, in contrast to the conditions in the wild, where the tree requires from 15 to 20 years to begin fruiting (Clement, 1993). Extractivist communities have initiated planting of Brazil nuts to enrich fallow sites.

Consumer restrictions on Brazil nuts include concern with aflatoxin content and the presence of radioactive selenium which is drawn into the tree tissues due to sulphur limitations in Amazon soils (Clement, 1993). The solution to the latter lies in applying sulphur through the tree bark, a practice already common among gatherers.

In the following section, a detailed case study regarding a recent experiment in community-based Brazil nut processing is presented to illustrate the complexity of matching social equity objectives with natural resource sustainability in the Amazon region.

3. Community Brazil nut processing: the CAEX case

The Agroextractive Cooperative of Xapuri (CAEX) was founded by the National Council of Rubber Tappers in the late 1980s to guarantee their usufruct rights to the resources found in extractive reserves, promote direct sales of their products, and make available regular supplies of basic consumer goods to extractive communities. Initially, therefore, CAEX focused on improving transportation links to the reserves, and increasing the availability there of commercial goods and social services, focusing on primary education and health care.

A key part of the Cooperative's strategy was to increase the value of Brazil nuts by developing export markets for processed or finished products. With funds from foreign donors, CAEX installed a modestly scaled Brazil nut factory in Xapuri, centre of the rubber tappers' movement. Other support went to technical assistance, research on the management of natural resources, working capital and machinery, and institution building. Almost US$ 1.8 million was donated to support this experiment in cooperative resource utilization and marketing.

The processing factory "Usina de Beneficiamento Chico Mendes" was built on the outskirts of Xapuri, with a capacity of over 400,000 tons of Brazil nuts annual production, beginning operations in late 1990. By 1992, it had become the largest private employer in Xapuri, and one of the largest industries in the rural state of Acre. The factory employed 92 women as shellers, who had been pushed off forest lands by cattle ranchers and timber operations.

Processing is separated into two stages: first shelling and sorting, and then packaging and preparation for shipment. The nuts are first dried and heated to release the moist nut from the shell. Care must be taken not to heat the nuts too quickly or to temperatures in excess of 60°C. This process takes 24 hours. The nuts are then placed in a water tank to soften the hard shell. The nuts are shelled on work tables using a simple mechanical cracking machine, one for each operator who cracks the raw nuts and sorts them into basic categories (primary, chipped or broken). Once shelled, the nuts are sorted by size (large, medium, small and midget), packaged, sealed, boxed, vacuum packed and labeled for shipment.

CAEX initially operated under the premise that each worker should earn at least one minimum wage (US$ 65) per month. Gatherers received a minimum wage for collecting 189 kilogrammes of nuts per month. In town, the shellers at the factory qualified for the minimum wage by producing 210 kilos of nuts per month. Other workers employed in processing were paid a minimum wage, or some multiple thereof. Not much thought was given about the impact of minimum standards on production costs, or how to determine appropriate production quotas.

High costs of production result from the harvest cycle of the Brazil nut, which begins in January and ends in April, leaving the factory idle for several months for lack of raw materials. Labour legislation in Brazil makes it both difficult and expensive to hire on a periodic or seasonal basis, which meant that many workers remained on the payroll whether the factory was running or not, adding to costs of operation. Worker productivity was low. Losses from spoilage were up to 40%.

Production costs in Bolivia and for CAEX are compared in table 6. The data show costs of production in 1993, when the entire Brazil nut crop was processed at the factory in Xapuri and for 1994, when the Brazil nuts were processed under a "decentralized" system, that is, where the nuts were shelled outside the plant on a part-time, piece-work, basis. The data show that raw material costs are much higher for CAEX than for Bolivian competitors, even though the latter have much higher capital investment costs.

CAEX directors began to realize that even by reducing the workforce, the costs of production were considerably higher than those faced in Bolivia, and they could not guarantee a profit on sales. To reduce wage costs of production, CAEX developed a decentralized processing scheme with both urban and rural forms. In the rural areas, small processing units were established at the community and household level. Urban decentralized processing in Xapuri takes the form of putting out shelling to the homes of workers who formerly worked as shellers in the plant. Rather than paying 71% social overhead costs, the Cooperative would eventually be obliged to pay 20% to a shellers' association. Shifting the shelling process to the rural community was seen as a way to increase value added in the forest and provide greater opportunities for those who live there to earn monetary income. Decentralizing the shelling was also expected to lower transportation costs, because water and the hard protective shell of the Brazil nuts account for over 60% of the weight. Their removal in the gathering areas would thus reduce bulk.

Table 6. Cost comparisons for shelled nuts production between CAEX (centralized and decentralized systems) and Bolivia

Costs of Production	*Centralized Urban 1993*	*Decentralized Urban 1994*	*Decentralized Rural 1994*	*Bolivia Manual 1993*
			(per kg shelled nuts)	
Raw materials costs				
1. Cost of raw material	$1.02	$1.02	$0.77	$0.39
2. Losses due to spoilage (estimated at 30%)	$0.44	$0.44	$0.33	$0.17
Total raw materials cost	**$1.46**	**$1.46**	**$1.10**	**$0.56**
Processing and Other Costs				
3. Processing costs*	$0.67	$0.52	$0.82	$0.55
4. Depreciation and finance	$0.06	$0.06	$0.06	$0.23
5. Delivery and marketing (ex factory/brokers' fees)	$0.14	$0.14	$0.14	$0.11
Total production cost	**$2.33**	**$2.18**	**$2.12**	**$1.45**

* includes transportation costs to the factory.

Family shellers were provided a water tank, drying platform and cracking machine. Processed nuts would be returned to local nuclei for final drying and packaging. In the decentralized processing unit, a dryer, wetting tank and final drying oven would be designed so that families could process their own nuts which would be sold to the central factory for packaging and final sale. In Xapuri, the Brazil nuts were sent to the homes of the workers who had formerly worked in the factory for shelling. Shelling at home involved receiving nuts in the shell that had been dried and moistened, and thus were ready for cracking. The nuts were delivered to the homes at the beginning of the day. Shelled nuts were returned to the factory at the end of the day.

Production under the decentralized system in rural areas did not run smoothly. Output per worker in the rural area was much lower than at the factory. Shellers were only able to shell about 6 kilos of nuts per day, versus 10.5 kg in the factory under the previous (centralized) system, and 12 to 13 kg per day output for the urban shellers. Erratic work habits were observed among rural workers, with an average work month of 11 days, rather than the predicted 20 days. Women lost interest in working and sent their children instead, at the expense of school attendance. Workers attrition was high due to delays in payment.

The decentralization model that was promoted by CAEX was predicated on the idea that there is a great deal of surplus labour in the rural areas. The reality is that because of high rates of rural-urban migration, and the fact that survival depends on the contributions of all the members of the family, there is in fact a shortage of labour. In towns such as Xapuri, on the other hand, the economic opportunities for women are extremely limited. The Xapuri labour force is almost entirely composed of ex-forest dwellers forced by violence, abandonment, or other personal catastrophe to move to the city. There they live in poverty on the minimum salary, credit, garden produce, remittances from family members, odd jobs and pooling income.

Without question, the CAEX factory became a symbol of progressive sustainable development and forest conservation. Yet high social costs, and the lack of a sufficient number of workers accustomed to wage labour, undermined the factory's competitive position with Brazil nut industries based in Bolivia. The difficult trade-off between improving rural living conditions and ensuring product competitiveness may pose a significant barrier to achieving consumer satisfaction and environmental protection through expanded output of natural products.

4. Product prospects

Brazil nuts are important products for poor extractivists in the Amazon who seasonally alternate their collection with rubber tapping in areas where both species are present. In this regard, maintenance of competitive Brazil nut trade could contribute to tropical forest protection and socially equitable development.

However, several factors have made Brazilian exports relatively uncompetitive with other Brazil nut producers, notably Bolivia, as well as stimulated substitution with other snack nuts such as cashews. Although there have been several efforts to encourage marketing of Brazil nuts produced within extractive reserves, including microenterprise support by foreign donors, direct purchase of nuts for use in candies and ice creams, these efforts have not yet guaranteed viable extraction and processing networks. More intensive production methods including agroforestry plantations and decentralized hulling and drying may enable a more competitive stance in the future.

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XI. Latex “vegetal leather” [5]

1. Product characteristics

The recently developed product "vegetal leather" is made from natural latex collected from the rubber tree, *Hevea brasiliensis*. The latex is poured over cotton sacks and vulcanized, producing a dark brown material with an appearance similar to leather. Rubber tappers traditionally produced small amounts of rubberized (non-vulcanized) sacks for their own usage, a product which inspired the development of a higher quality product for international markets. Long a traditional source of income for Amazonian forest dwellers, naturally gathered latex suffered a drastic price drop in recent years with the loss of Brazilian government trade protection. Vegetal leather offers the prospect of an improved price for a value-added product.

2. The rubber market crisis and environment in the Amazon

Although *Hevea* originated there, the Amazon region now produces only 1% of world output and approximately 25% of the total requirements of natural rubber in Brazil itself. Approximately 80% of production is consumed by the domestic tire industry. To supply remaining demand, Brazil imports rubber principally from Malaysia, constituting an annual cost in foreign exchange of between US$ 150 and 200 million. A considerable area was planted in cloned rubber seedlings in São Paulo and Mato Grosso during the past decade, that could potentially supply the entire domestic market. Planting in the Amazon region itself is impeded by the spread of South American Leaf Blight (SALB) caused by the *Microcyclus uleii* fungus.

Native rubber is extracted from trees that occur naturally at very low density, thus avoiding fungal attack. Although the figure varies regionally, the number of native rubber trees in the Amazon is on average less than two trees per hectare. Rubber tappers are settlers and indigenous peoples principally located in the states of Acre, Rondônia, Pará and Amazonas. There are estimated to be about 300,000 people whose household income is derived in part from this activity in the Amazon region.

The economic importance of natural rubber as a source of income for Amazon forest peoples was sustained through price supports until recent years. From an average price of US $1.33/kg throughout the 1970s (in 1980 constant dollars), the price fell to $0.72 in 1987 and $0.50 in 1995 (nominal price), due to the gradual removal of support prices and compensatory taxation on imports in the early 1990s, and the elimination of quotas that destined domestic production for buffer stock formation at favored prices.

The decline in the domestic price of rubber caused an exodus from rubber stands, and the substitution of latex collection by other activities. Nevertheless, Amazon producers maintained an average output of 23 thousand tons annually throughout much of this period, reflecting the lack of significant economic alternatives. However, by 1991, this had fallen to approximately 14,500 tons of rubber. The rubber tappers' movement argues that deforestation in regions having high *Hevea* densities could be averted if the population, which has recently been mobilized for creation of

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[5] Segments of this study were investigated by Fulbright Fellow Louise Silberling of Cornell University drawing data derived from her fieldwork in Acre and consultations elsewhere in Brazil.

extractivist reserves, can continue this traditional activity. This would justify the internalization of environmental protection costs in native rubber prices, and efforts to develop higher value "green" products such as "vegetal leather" (May, 1990).

3. Vegetal leather production and processing

To make vegetal leather, latex is sustainably gathered in the traditional way, by making small horizontal cuts in the rubber tree bark and letting the latex flow into a small cup. The cups are then emptied into a larger container, brought back to the rubber tapper's home site and processed. Rubber trees have been tapped in this way in many cases for 50 to 100 years or more. Trees tapped by the three new communities are all wild *Hevea*, while trees tapped in Boca do Acre include more recently planted trees.

Rubber tapping is traditionally done by individual tappers on the rubber trails belonging to their household area, averaging from 300 to 500 ha per household (de Paula, 1989). Each tapper produces on average 450 kg/yr, or an output of less than 2 kg/ha. The same trees are tapped year after year and are typically well taken care of. Rubber has long been the main source of cash income for traditional forest dwellers in Acre, first under exploitative labour relations, with harsh bosses and rubber "barons" and now more often under credit relationships with middlemen.

Vegetal leather offers not only three times or more cash income than regular rubber sales, but also offers the prospect of increased independence from middlemen or bosses. In the case of the Alto Juruá Extractive Reserve, vegetal leather may help to ensure the future of this new kind of conservation unit by fixing the residents in the reserve and discouraging the expansion of agricultural activities to generate income.

The latex is poured over pure cotton sacks, 60x80 cm, normally used for shipping 50 kg of sugar or flour. These sacks are bought pre-made wholesale by Couro Vegetal, S.A. and distributed to the local tappers. The sacks are stretched over a wooden frame and smoked over a wood fire. They are then left in the sun to turn dark brown, and are then put in a specially constructed "dry house" to reduce water content. Finally, they are vulcanized. The sacks are checked on-site during collection for initial quality control, before trucking to Rio de Janeiro for further quality control and marketing.

The vegetal leather concept was developed by the business group EcoMercado of Rio de Janeiro, Brazil. Product development and marketing is done exclusively by a subsidiary company, Couro Vegetal da Amazônia, S.A., which has patented part of the vulcanization process in use. This company has worked closely with Boca do Acre religious community in the state of Amazonas since 1991 to develop the product and to improve product quality, introducing processing methods and quality control standards. The company has also provided technical assistance and processing materials to three additional communities in western Acre.

Expansion of production to new sites in Acre has been undertaken by Couro Vegetal S.A. with trainers from Boca do Acre. Training-of-trainers is done on-site in other communities. These new trainers then act as experimental and demonstration sites, working on bringing quality and quantity of production up to par. Once this is achieved, they train other producers in the same community. Couro Vegetal S.A. works through tribal leaders or community leaders and association representatives.

Currently, vegetal leather is made only by the following producer groups: Yawanawá and Kaxinawá indians, rubber tappers from the Alto Juruá Extractive Reserve in western Acre, and members of Boca do Acre community in southeastern Amazonas. The new work opportunities generated with this activity have attracted 52 Yawanawá Indians to return to their ancestral lands, according to a recent report (Instituto Acqua, 1995). All production is sold under three-year contract to Couro Vegetal S.A., which markets either the raw or finished product internationally. The raw product, vulcanized latex on cotton sacks, is called "Treetap®" by Couro Vegetal, S.A.

4. Problems related to expanded production

Couro Vegetal, S.A. developed final products such as daypacks, briefcases, and toiletry cases for sale in the national and international market. However, production of these final products proved too expensive due to labour and design costs as well as quality problems. Labour costs in Brazil are higher than those in Asia, where most mid-price leather and synthetic leather products are currently made, with the result that production of finished goods has become prohibitively expensive in Brazil. Therefore, the company has resorted to selling the raw product (latex-covered sack), marketing approximately 100,000 sacks per year at US$ 9.12 apiece. The raw square-foot cost of US$ 2.16 of vegetal leather is almost three times that of vinyl, but is less than leather. Raw product production costs at the site of production may be reduced in the near future by simplifying the production process and by reducing production time required, for example during the vulcanization process.

Twenty per cent of the vegetal leather is currently consumed by Deja Shoe, an American company which won international recognition in 1994 for its manufacture of ecologically sound products. Deja Shoe produces a low boot which sells for approximately US$ 59. This company has worked with Couro Vegetal S.A. to improve quality standards and to manipulate the raw product, for example improving colour standardization and developing post-production care procedures.

Quality of the raw and finished product has been of great concern. The product tends to degrade more quickly than leather or vinyl, causing Couro Vegetal S.A. to replace its finished goods sold to consumers at EcoMercado in 1992. Longevity of consistency and colour retention, especially when exposed repeatedly to chemicals derived from petroleum products, salt, water, direct heat, or prolonged intense sun, were major concerns, until the introduction of the improved vulcanization process and adoption of quality control procedures developed by Deja Shoe. Couro Vegetal S.A. continues to invest in technical consultancies to research and develop solutions to this problem. Currently, up to 35% of vulcanized sacks at new production sites are rejected due to quality control difficulties, including sack size and surface flaws.

While working constantly to improve quality and lower production costs, Couro Vegetal S.A. is seeking to expand its markets. Production at Boca do Acre can be expanded immediately, and production at other sites in Acre and in the future in other Amazonian states will expand more slowly. Current output, estimated in 40,000 sheets, is anticipated to expand to 300,000 over a three-year period (Instituto Acqua, 1995). Production in the Juruá valley and in Boca do Acre is expected to total over 600,000 sheets per year within the next five years.

A strong market niche for this "green" product, most likely in Europe and the United States, will have to be developed due to the expense of the product. The handbag market alone is worth US$ 2 billion, offering considerable promise for this product. In the "green" market, companies such as Aveda have shown interest in using vegetal leather in packaging.

5. Sustainable production and market prospects

While it is considered unlikely that vegetal leather production would be expanded to include the entire traditional population of rubber tappers, a significant fraction of these forest dwellers could eventually be retained in the forest with this sustainable, value-added activity. Substitutability of the product can be avoided with the development and retention of a specialized market niche. The role of companies dedicated to purchasing raw materials produced in an environmentally sound fashion such as Couro Vegetal S.A. and Deja Shoe is important in initially carving out this niche, but broader markets may become accessible in future.

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XII. Babaçu palm fruit products

1. Product characteristics and environmental attributes

Babaçu palms reach 30 m or more at maturity, with an upswept frond canopy, producing fruit bunches that weigh on average 60 kg. Monospecific palm stands of babaçu cover extensive areas of Brazil's pre-Amazon and savanna regions, where a cottage industry of fruit extraction associated with a regional vegetable oil industry arose over the past half-century. Babaçu products contributed on average 22% of household income from all sources to as many as 420,000 impoverished rural households in Brazil (Queiroz, 1989; Mattar, 1979). Markley (1971) refers to this complex as the "largest oil industry of its kind in the world based on a wild plant".

Babaçu (in Tupi-Guarani: *uauaçu*, the "tree of life") has been taxonomically defined as *Orbignya phalerata* Mart., although there are a number of related neotropical palm species and families whose physical characteristics and oil kernel composition are similar. These include *O. cohune* ("corozo") found in Mexico, Central America and the Antilles, and a number of *Attalea* species found throughout the South American tropics (Anderson et al., 1991).

Despite this broad distribution, babaçu palms are found in greatest density in the Mid-North transition zone between the semi-arid Northeast, the central savanna of Tocantins and the humid Amazon rainforest. There, the palm has colonized dispersed sites in an aggressive manner after original semi-deciduous and tropical forests were cleared for cotton and sugarcane plantations in the 18th and 19th centuries and later, for shifting cultivation of food crops. In some locations where it occurs far from its centre of diffusion at the confluence of the Tocantins and Araguaia rivers, babaçu was probably transplanted by indigenous peoples who valued it for its fibre, food and fuel potential. Today, there are estimated to be over 200 thousand km^2 covered with monospecific babaçu forests (MIC/STI, 1982).

Babaçu's aggressiveness is derived from its cryptogeal underground germination and its consequent ability to sustain the repeated cutting and burning associated with shifting cultivation and pasture management. Although this feature makes the palm hated by ranchers who yearn for open pastures, it has endeared it to a poverty-stricken peasantry who have historically depended for a good share of their livelihood on the palm.

Although it establishes rapidly, the palm grows slowly to maturity, mostly due to competition from other palms and woody vegetation, with an estimated age of 15 years under ideal conditions at the initiation of fruiting. Its biomass turnover, however, is impressive, making it one of the most productive trees in the tropics in these terms: an average stand produces about 17 tons per year and hectare of biomass dry matter, mostly in the form of leaves (Anderson et al., 1991). This leaf productivity makes it possible for shifting cultivators to cut palm leaves rather than stems, thus benefiting from the multitude of products derived from the palm during the fallow cycle. Similarly, pasture management, typically accomplished through burning in this region, does not sacrifice palm productivity in subsequent seasons. Babaçu is thus tightly integrated with extensive land use practices.

However, when land use intensity is increased, the "subsidy from nature" derived from babaçu palms is prejudiced (Hecht et al., 1988). Massive deforestation in the babaçu zone over the past decades, particularly for establishment of improved (and hence treeless) pastures has pushed small farmers into areas formerly managed as common property resources, forcing them to cut the very palms on which they rely for their subsistence. This phenomenon has been termed a "non-common tragedy", resulting from privatization of natural resources (May, 1990).

The contribution of babaçu products to subsistence needs (May et al., 1985a), agroforestry ecosystems (May et al., 1985b) and cash requirements - constituting from 27 to 30% of total household income (May, 1990) - represent benefits which are inversely associated with the level of household income and its control over land. The fact that most fruit gathering and breaking is done by women near the home, and the income so generated accrues to their control, makes this product of interest from the viewpoint of gender equality.

2. Problems affecting production expansion and technical solutions

Fruit productivity has been perceived as a stumbling block in development of babaçu industries. Palms in dense stands produce on average less than one bunch of fruit annually, leading to an average productivity of 1.8 tons per hectare of fruit. Dispersed and unproductive stands combined with the distance and inaccessibility of rural settlements make gathering and transport costs prohibitive. Only about one third of potential babaçu output has ever been effectively gathered for kernel extraction (Pick et al., 1985). These factors have contributed to the perception by landowners that the palm forests would be best eliminated.

However, it is apparently possible to at least double palm productivity by thinning stands and managing understory regrowth, both common practices in pasture stands of babaçu. Even greater increments could be obtained by selection of high-yielding varieties in the wild and establishment of agroforestry plantations (Balick, pers. comm.). Nevertheless, it is not so much the productivity of native stands that limits their contribution to small farmer incomes but rather these farmers' access to the stands, which has been progressively circumscribed as ranching establishments appropriate and convert forestland in the eastern Amazon (May, 1990).

Entrepreneurial efforts to increase utilization of babaçu forests have focused instead on industrialization of fruit breaking rather than on either stand management or species improvement. But they have discovered, after nearly a century of failed efforts in this regard, that babaçu is a proverbial "hard nut to crack". The fruit are composed of four consecutive layers: a fibrous epicarp (15% by weight), starchy mesocarp (21%); woody endocarp (58%) and oil kernel (6%). Due to the random positioning of kernels inside the endocarp, variable size of fruit and differences in proportions among fruit constituents, such industrialization attempts have been destined to failure, particularly those that were promoted at massive scale with centralized processing that would depend on complex logistics of whole fruit supply.

Nevertheless, a more recently adopted technology based on the peeling of fruit epicarp, and subsequent breakage and separation of constituents (PQS — *pelagem-quebra-separação*) has shown promise, particularly in small farm- or community-based units. At an installed cost on the order of US$ 7,000, such equipment, designed and fabricated in the Brazilian Northeast, is capable of husking, breaking and separating up to 18 tons of fruit daily. The only operational drawback is its infernal racket, particularly in the breaker, whose centrifuge hurls endocarp against the walls of a steel drum to break them and shake kernels loose from their cavities. Final separation of kernels is done manually in a salt bath. Fibrous material remaining is removed from the mesocarp powder on a vibratory screen. Although the equipment requires electrical or diesel power, it may be possible to generate energy locally by burning epicarp fibers. Charcoal produced from peeled endocarp is of higher quality, and mesocarp meal may provide an important supplementary source of income from fruit processing (Gastel, 1994).

There is also a strong social rationale for community processing. Proposals for development of centralized babaçu industries had generated serious controversy with rural labour organizations in the region, concerned with the expulsion of poor households reliant on babaçu for a significant proportion of their incomes. While industrialists argued that labourers could potentially earn more gathering whole fruit, it was invariably men who were employed in such work, while women were denied access to stands and could suffer a possible decline in kernel prices due to expanded industrial output. This represented an insidious stage in the resource privatization that had infringed upon babaçu gatherers' access rights to the palms over the previous decades (COPALJ-ASSEMA, 1993). Small-scale community-operated processing schemes could be more acceptable for social reasons and would also overcome the logistical problems inherent in transport of whole fruit from dispersed sites to a central processing plant.

Technological problems inherent in these processing options remain serious bottlenecks to be overcome, but rural producers' organizations have been formed and are actively testing a range of technical and marketing alternatives (Gastel, 1994).

3. Market prospects for babaçu oil

Babaçu kernels present an oil content of at most 60%, whose chemical composition is proportionally high in lauric acid, rendering it similar to coconut oil, important in soaps and cosmetics manufacture. Despite low yields from native stands, babaçu oil historically enjoyed virtual hegemony in the Brazilian coco oil market. (Brazilian coconuts are destined principally for the food industry or are consumed directly as a refreshment.) This domestic economic importance was not paralleled in international markets, where babaçu oil has only penetrated sporadically, on a five-year cycle that reflects scarcities of coconut and palmistic oils due to climatic events and pests in Southeast Asia. Oil cake and meal (32% yield from kernels processed in regional presses) have, however, found ready buyers in the low countries, where they are used as a component in livestock ration.

Oil output from babaçu kernels peaked at 80,000 tons per year in the late 1980s, corresponding to extraction from 1.2 million tons of fruit, having a final market value of US$ 40 million. Cheap credit available to industrial investors in the depressed Northeast had stimulated expansion of the kernel crushing capacity to a level superior to that of native stand production potential (May, 1990). A number of factors contributed to a decline in its market significance since that time. The recession of the 1980s reduced industrial demand for raw babaçu oil, which began to be substituted for cheaper tallow or the oil content of bar soaps adjusted downward. Demand for saturated vegetable fats had been flattened by alarms over the cholesterol content of peoples' diets, which obliterated the market for babaçu shortening. Synthetic petroleum-based detergents became more popular than oil-based soaps for cleaning and clothes washing. Finally, removal of import restrictions against imported coconut and palmistic oils through market liberalization of the early 1990s has dealt a serious blow to what was already a crippled industry (May, 1992).

Despite declining demand, babaçu oil continues to be used in regional soaps and cosmetics industries, and annual exports were registered throughout the 1985-94 period, with peaks in 1985 (5,618 tons) and 1992 (1,500 tons) to buyers primarily in Argentina, the United States and the UK.

Average export prices from 1985-94 were only US$ 0.78 per kg oil (CACEX/DTIC/CEDIV), however, while domestic producer values for kernel hovered at the $ 0.20 per kg level through the end of the 1980s (FIBGE). With outmoded oil presses that rarely obtain yields in excess of 50% oil per kernel volume and a complex marketing chain that can more than double raw material costs placed at the plant, it is only a favourable market for press cake and meal that has enabled traditional oil mills to continue operating. Thus, unless kernel production costs can be significantly reduced, a larger number of by-products obtained, or an ecolabel premium attached to the sale of oil to ensure a more remunerative enterprise, the prospects for babaçu oil must be considered fairly bleak.

One means to add value to babaçu kernels that has evolved is the organization of oil and soap industries operated by extractivist communities themselves. Beginning in 1991, a cooperative movement among small agroextractivist producers was initiated in central Maranhão. The cooperatives purchase and press babaçu kernels, sell basic foods and household necessities to their members, and are considering agroforestry systems establishment within babaçu stands, including production of other perennial crops (COPALJ-ASSEMA, 1993). Women in these communities have furthermore organized small-scale artisanal soap manufacturing enterprises. Development of alternative by-products, such as charcoal and mesocarp meal, are also being actively considered by the Maranhão marketing cooperatives. Operating at a scale of up to 10 tons of kernels per week , the cooperatives are exploring opportunities to market raw babaçu oil to European natural cosmetics manufacturers concerned with the socio-environmental benefits that are being generated by these enterprises.

The acceptability of raw babaçu oil has been a drawback to international marketing in the past, requiring that the cooperatives pay for batch refining of oil. This difficulty may be overcome with the willingness of some consumers to accept raw oil directly. In summary, therefore, although domestic markets are experiencing a rapid shrinkage due to imports of substitutes, promising opportunities may exist for small-scale oil processors to reach non-traditional and more remunerative markets overseas.

4. Market prospects for non-traditional products

Charcoal from babaçu husks has long been the principal fuel used for cooking in rural households in the palm zone. In the wake of the two petroleum price shocks, Brazilian energy strategists were charged with exploring prospects for utilization of babaçu fruit for siderurgical coke and even ethanol. Technology assessments undertaken during the 1950s found that babaçu charcoal possesses high caloric potential, superior fixed carbon and low sulphur content, which makes it a potentially attractive complement to the charcoal used for a good share of metallurgical reduction in Brazil. In this case, babaçu charcoal — which is subject to disintegration when carbonized after kernel extraction — would be most desirably briquetted to avoid collapse under the weight of iron ore charges in reduction columns (Kono, 1992). Alternatively, whole babaçu fruit or peeled endocarp could be converted to charcoal, an option that is currently being tested by a pig iron manufacturer in Pará. There is also a potential for favourable market acceptance in the form of activated charcoal, but purity is an essential factor in this market for which small-scale enterprises may be insufficiently prepared. Prices obtained in the Brazilian market range from US$ 45 per ton for indiscriminate material supplied to pig iron foundries to $ 75 per ton for peeled endocarp charcoal supplied for activated charcoal and automobile foundries. At the upper end, this market might compensate community-based investment in improved charcoal kilns and in sifting the material to segregate grain size (Gastel, 1994).

Babaçu mesocarp meal is currently processed by sifting out impurities at a small scale to serve the popular medicines market of the Northeast, being prescribed against a surprising variety of maladies. However, the basic constituent of the mesocarp is starch, which could be fairly easily purified and marketed to the food industry. For larger volumes, the use of the PQS mesocarp peeler, together with a starch grinder and cyclone is being considered. Interest in purchasing mesocarp meal has been expressed by an Italian firm, offering a producer price of about US$ 1.50 per kg.

5. Conclusions

Babaçu palm utilization complements household income of hundreds of thousands of impoverished rural households, whose agricultural systems are closely intertwined with the stands, enabling a coexistence which is environmentally and socially beneficial. Low product values, market substitution, poor productivity of native palms and dispersal of production have contributed to undermine this system, which has stimulated land-use conversion and expulsion of the peasantry.

Recent efforts to revert this tendency have relied on grass roots organization of agroextractivist communities, their obtaining secure land rights over palm stands, community enterprise development and the discovery of alternative by-product markets that can add further value to babaçu fruit processing. The latter will require further investment in pilot processing technology, but many of the technical barriers in this regard have been overcome. Social organization of the peasantry in this region has been a slow but rewarding process, in which the involvement of rural women in key leadership roles has been notable.

Potentials for expansion in production of raw babaçu oil are weak, due to to declining domestic demand. By-product options depend upon successful adaptation of appropriately scaled processing technology. Purity of charcoal for filtration, and insistence on oil refinement have presented stumbling blocks to entry in higher value export markets. These barriers may be overcome if the socio-environmental values of babaçu are recognized by potential consumers.

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XIII. Palmito

Palm heart represents a major source of income for inhabitants of the Amazon estuary and south coastal region of Brazil, and responds to strong international demand. The palmito agroindustry in Brazil — the world's principal producer, consumer and exporter — is based practically entirely on extraction from native palms. The industry began in Atlantic Forest areas extending from Bahia in the northeast to Paraná in the south, extracting palm heart from jussara palm (*Euterpe edulis*) as raw material. Once these reserves began to be exhausted, the industry migrated to the state of Pará in the Amazon estuary, where it utilizes primarily açaí palm heart (*Euterpe oleracea*) and *E. precatoria,* derived from upland forests, in lesser volume. Pará currently is the major source of Brazilian palmito, responsible for 90% of national output.

Development of alternative palm sources for palmito other than the *Euterpe* genus is desirable, due to difficulties in its use as a plantation crop, such as lengthy maturation and low productivity. Pupunha or "peach" palms (*Bactris gasipaes*), known in Spanish as *pejibaye*, have been studied for many years as a viable substitute for açaí, reflecting experience in Costa Rica with this crop, where it yields from 1.3-1.8 t/ha and begins production as little as two years after planting (Smith, 1992).

In the following discussion, the interplay among resource sustainability and consumer demand in the palmito market is explored.

1. Characteristics and environmental attributes of açaí palm

Açaí (*Euterpe oleracea*) is distinguished by its fine long arching stems that reach 25 m in length and by its deep purple cherry-sized fruit, produced in long bunches. The palm yields both the fruit "wine", having high energy content — an important food to the poor population residing in the Amazon estuary — and palm heart, derived from the base of the stem. The palm also is used for ornamental purposes and the fruit, when decomposed, as a source of organic fertilizer.

Commercial extraction of açaí palmito began in the Amazon estuary in the early 1960s as a consequence of decimation of *E. edulis* in southern Brazil (Bovi and Castro, 1993). The great advantage of açaí is that it grows in clumps; the cutting of one stem does not result in mortality to the clump, unless the growing point is damaged. Clumps usually have from 4 to 8 stems in various stages of growth, and one or two palms can be harvested for palmito annually under a managed rotation (Anderson and Jardim, 1989).

Açaí palms are distributed principally in the states of Pará, Amapá and Maranhão in the estuaries of the Pará and Amazonas rivers, in areas having over 1,800 mm of rainfall. Although abundant and theoretically sustainable, there is some concern regarding the indiscriminate and predatory extraction of palmito from wild stands. The number of easily accessible native stands has been reduced substantially during the last 20 years with destructive exploitation (Bryon, 1994).

Propagation can be from seed or by transplanting, although the latter technique is more complex, causing fragility in the plant. On the other hand, the palm propagates simultaneously from the stem and through natural seed dispersion by birds. Management of açaí requires consideration of the adequate economic trade-off between fruit and palmito production.

2. Characteristics and environmental attributes of pupunha (cabbage) palm

Pupunha (*Bactris gasipaes*) can be planted in a range of climate conditions, but performs best in hot and humid areas. It is adapted to low fertility soils, and begins production within two years, producing large-diameter palm heart, and weight greater than that derived from açaí, characteristics desirable to the industry. On the other hand, production costs are relatively higher than those necessary for extractive production of açaí, due to the need to establish plantation production (Lima and Miranda, 1991).

Nevertheless, pupunha is a permanent crop that can be managed for continuous harvesting of palm heart. Its abundant thorns historically impeded its utilization in Brazil. Researchers at the National Institute for Amazon Research have disseminated thornless varieties based on Peruvian germ plasm, that have great promise.

Currently, there is only one commercial plantation of 300 ha of pupunha located in the state of Acre. Experimental plantings have been initiated in various areas, and in Bahia and Espirito Santo, larger-scale enterprises have been established (SEPROR, 1991).

3. Palmito processing techniques

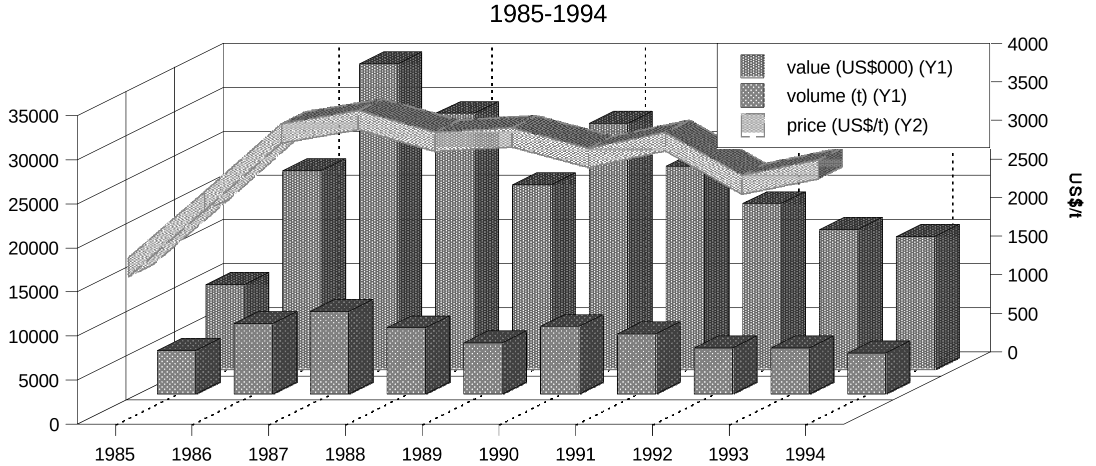
Palmito derived from açaí is canned through a process that involves 15 or more stages, beginning with cutting of the palm and sustained management. Care must be taken to avoid that the heart is not bruised in falling, which can cause fracture or squeezing of the palm heart that would make it inappropriate for market.

The palm stem is removed while still in the forest, to reduce the volume that must be transported. Cutting must avoid the palm heart itself, which would result in risk of spoilage, particularly in rainy periods. The material is transported carefully under cover to ensure that bruises and spoilage do not occur. Unprocessed palm heart is extremely perishable, remaining fresh for a maximum of 48 hours. Thus the supply of raw material is by necessity a daily activity, obliging processors to install canning operations close to point of origin, often on floating barges in the estuarine region. This feature ensures that local employment is generated through palmito extraction and processing.

Palm hearts are selected preferentially with over 2.5 cm diameter, in an effort to avoid the removal of immature and overly slender palms that have lower commercial value. An initial peeling is made to remove three or four layers of the fibrous covering that envelopes the heart, leaving only one layer covering the edible segment. A final peeling operation removes this last fibrous layer, avoiding bruises that could darken and thus harm the palmito's commercial value.The palmito is finally cut to the length desired by buyers and immediately immersed in a salt solution containing citric acid, for canning under vacuum. The canned palmito is boiled and rapidly cooled. Canned palmito remains saleable for between four and five years.

One means to reduce overharvesting and consequent damage to native açaí stands is to adopt rigorous controls over the diameter of palmito that industries may accept for canning. Such measures would make younger stems unmarketable, thus forcing cutters to adopt less predatory management techniques (Harrison Pollack, pers. comm.).

Figure 4. Palmito trade and prices



Source: CACEX/DTIC/CEDIV.

The structure of the palmito industry can be differentiated by scale and function (Bryon, 1994). Inputs, equipment, canning and materials are supplied by one segment based outside the Amazon. A second segment is made up of large firms generally based in São Paulo that receive canned palmito in Belém from exclusive suppliers in the North for final labelling and shipment. Some firms request permits for forest management from the national environmental agency IBAMA, which enables them to receive palmito extracted from lands they rent or purchase, under contract with suppliers. In other cases, the firm furnishes equipment and processing technology to landowners that commit themselves to supply such firms exclusively. A third segment includes smaller production units and individual agents active in palmito extraction and processing in small mobile plants. There were some 114 suppliers active in the state of Pará in the mid-1980s; this number has increased significantly since that time (Silva et al., 1991).

4. Problems affecting expansion in palmito production amd trade

Palmito prices in the international market have varied over the past decade, demonstrating an initial surge, with consequent stabilization. In 1985, free-on-board prices were on the order of US$ 2,000/ton; this value rose to above US$ 3,000 by 1987, declining in subsequent years. Over the same period, the total value of Brazilian exports increased from US$ 10 million in 1985 to US$ 35 million in 1987, declining by 1993 and 1994 to about US$ 15 million (fig. 4). Responding to favourable prices, output also increased, peaking in 1987 at 9,400 tons, but descending to a fairly stable level of about 5,000 tons in the 1990s. This suggests exhaustion of accessible native stands of açaí in Pará.

The potential national and international market for palmito is primarily urban and is restricted to middle- and upper-class consumers with a high income elasticity of demand. The United States and France consume nearly 90% of Brazilian exports.

It appears, however, that palmito production by extraction from native stands of açaí has reached a limit; supply in future will be based on extraction from more distant and hence more costly sites, or through commercial planting of pupunha. Improved management of existing açaí stands would be a desirable approach to avoid such costly substitution, but controls are inadequate at present to monitor extraction, or motivate producers to protect immature stems. Studies by researchers at the Emílio Goeldi Museum in Belém have suggested a range of management principles that could be adopted at low cost by estuarine producers (Anderson and Jardim, 1989).

5. Prospects for palmito production and trade

Palmito harvesting from native sources has been a predatory process in Brazil, due to insufficient expression of property rights and presence of a rather rudimentary agroindustrial structure for palmito processing. Given the continued strong international and domestic demand for palmito, it appears likely that pupunha may come to supplant a portion of palmito supply from açaí in the near future. Pupunha is perceived to offer the advantage of faster growth to maturity, thick and better quality (less fibrous) palmito, and broad-based acceptance by consumers. The palm has excellent prospects for production within diversified agroforestry systems, offering environmental benefits for recuperation of marginal soils.

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XIV. Conclusions and recommendations

This report describes a preliminary selection of products originating in Brazil whose production, processing or disposal could be classified as "environmentally friendly". Details were provided of production and processing technology that are used for each product selected. Product profiles review the history of production and trade, potentials and bottlenecks for production expansion to satisfy eventual consumer demand, and institutional issues of production organization, quality norms and certification procedures.

The products reviewed range widely in terms of their relative importance to the national economy, from ethyl alcohol, with a final value at the pump of about US$ 6 billion/yr, to minor forest products whose consumption does not exceed the million dollar range. In general terms, readers of the report may conclude that the scope and magnitude of product substitution possibilities is rather limited, even from a nation whose continental size and broad ecosystem range would suggest more ample opportunities in this regard.

However, it is important to consider that some such products, even though small in gross value terms, may be crucial to survival of marginalized forest peoples, enabling them to satisfactorily protect their (and the planet's) biological resource base. For this reason, mechanisms to ensure that producers of such goods obtain price premiums to compensate for the additional environmental benefits derived from products of this nature should be treated as a priority issue for international trade and environmental policy. Even more vital to the survival of these product options is the provision of technical assistance in quality control, market research and penetration, and enterprise management.

Certification of environmentally sustainable production technology remains a controversial subject, although there have been significant advances toward definition of standards in this respect for some primary products, particularly tropical timber (not described in this report) and coffee. It is also notable that many firms profess knowledge of ISO 14.000 criteria and have devised tools to support environmental management. One of the areas of controversy perhaps not adequately addressed to date is that of differential pollutant absorption or carrying capacity, which may vary significantly between producer areas, thus resulting in the need to maintain certification standards flexible so as to assure economic efficiency in the use of such quality control measures.

Efforts to organize alternative marketing channels have not always been recompensed by significant price differentials or volume demands, which suggests that this type of effort has public good characteristics that might merit investment by international institutions. The progress made by nongovernmental organizations with support mainly from private foundations has been important, but now deserves complementation from multilateral sources.

We have concentrated in this report chiefly on renewable products and energy resources, rather than on recyclables. Recycling of newsprint and cardboard in Brazil is fairly commonplace. However, despite the importance of raw mineral and metallurgical product exports to the Brazilian national economy (having a combined value of about 28% of all exports in 1991), the scrap and recycled metal industry is restricted primarily to aluminum. There is considerable scope for development in this sector, although the nation's vast mineral reserves and transactions costs in scrap metal collection tend to militate against market formation. The issue of erecting trade barriers to promote recycling (recycled content requirements) which has been contested by virgin cellulose exporters to the European paper industry, can be anticipated to provoke negative reaction from ore exporters as well. Further work should be done to consider mechanisms to promote recycled product content in international trade.

A full consideration of the potentials for development of environmentally friendly products must take into account means to alter consumers' perceptions, attitudes and preferences. This report has focused primarily on the problems which impede market expansion on the producer side, although the problems of consumer acceptance of partially blemished produce has been mentioned as an impediment to widening of organic coffee markets, for example. Study of means to overcome consumer rejection through marketing and public information campaigns should be made an important component of further research in this area.