ISSN 1415-4765

TEXTO PARA DISCUSSÃO Nº 682

VALUE DETERMINANTS OF PLANT EXTRACTIVISM IN BRAZIL

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An analysis of the data from the IBGE Agricultural Census

Rio de Janeiro, novembro de 1999

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ISSN 1415-4765

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SUMÁRIO

RESUMO

Neste trabalho, analisam-se a estrutura e o desenvolvimento da extração vegetal no Brasil. Esse subsetor da agricultura recebeu muita atenção internacional pelo potencial que lhe é atribuído para o uso sustentável das florestas tropicais e de outros ecossistemas naturais, por exemplo, com a colheita de produtos não-madeireiros nas reservas extrativistas. A fonte principal de dados utilizada aqui é o último Censo Agropecuário do IBGE (1995/96), o qual se avalia criticamente. A extração no território do Brasil é descrita em termos gerais; especificamente para a Amazônia Legal, as causas da variação de valores entre áreas são analisadas por meio de instrumentos econométricos. O trabalho mostra que a extração vegetal sofreu um declínio estrutural em relação aos cultivos agrícolas, uma tendência que se acelerou na última década. Os valores não-madeireiros constituem um menor segmento do setor extrativo e são extremamente concentrados em poucos produtos e em áreas geográficas com características ecológicas especiais, as quais são pouco representativas para as florestas tropicais, num sentido mais amplo. Conseqüentemente, as perspectivas favoráveis para a extração não-madeireira, encontradas em estudos de caso anteriores, podem ser excessivamente otimistas, porque seus resultados não são aplicáveis para um cenário mais geral.

ABSTRACT

This study analyses the structure and development trends for plant extraction in Brazil. It is a sub-sector of agriculture that has received considerable international attention, due to its alleged potentials for promoting the sustainable use of tropical forests and other natural ecosystems, e.g. through the harvesting of non-wood products in extractive reserves. The main data source is the latest Agricultural Census (1995/96) from IBGE, the Brazilian Statistical Office — a source that possesses both strengths and weaknesses. Extraction in all of Brazil is described generally; for the Legal Amazon, causes of spatial value differences are explained econometrically. It is found that extraction exhibits a long-run structural decline *vis-à-vis* agricultural cultivation, which accelerates during the last decade. Non-wood values, a minor element within that sector, occur extremely concentrated on a few products and market-near geographical areas with special ecological characteristics, that are little representative for tropical forests in a wider sense. It is concluded that the favourable outlook on non-wood extraction, promoted by other scholars' previous, site-specific case studies, may be over-optimistic if applied to a more general setting.

1 - INTRODUCTION[1]

In the writings on the economic history of Brazil, plant extractivism — a production system based on human's removal of biomass from natural ecosystems — has consistently been equated to backwardness. A classical Brazilian historian like Buarque de Holanda sees historical extractivist systems, adapted by the Portuguese colonists from indigenous traditions, as a logical response to a land-abundant physical environment with constrained tropical soils, abundant plagues and labour scarcity. However, to him it is also a system led by the Iberian *conquistador* spirit of resource-mining and commerce, allowing to harvest the fruits of nature without the organised and laborious effort of land cultivation [see Buarque de Holanda (1978) [1936]: ch. 2]. On the other hand, the contemporary Gilberto Freyre actually credits the Portuguese for their pioneer efforts to shift from 'pure extraction' to agriculture. The creation of a plantation colony for him entails the 'local creation of wealth', and 'the use and development of plant richness by means of capital and individual effort' [see Freyre (1977) [1933]: 17, my translation from Portuguese]. This inferiority view on extractivism *vis-à-vis* agriculture is shared by later economic historians, such as [Furtado (1970: ch. XXIII) and Prado Júnior (1978: ch. 9)], and refined for a current setting in the theory about a product-wise, stage-led rise and decline of extractivism [see Homma (1993, 1994, and 1996)].

Nevertheless, extractivism has received a new impetus since the 1980s, backed by those concerned with the sustainability of production and the conservation of biological diversity. In this discussion, Brazil, with its large share of the Amazon, has been a strategically important case. While timber extraction is recognised by most as ecologically damaging, the extraction of non-wood forest products was seen as a socially, economically and ecologically viable alternative to widespread forest conversion, especially in the Amazon [see Allegretti (1990 and 1994); Nepstad and Schwartzman (1992); Ruíz and Pinzón (1995); Broekhoven (1996)]. Other observers have viewed the scope for extractivism with a certain hesitation [Fearnside (1989); Clüsener-Godt and Sachs (1994); Assies (1997)] or outright

[1] A large number of people have contributed to the making of the present work. I am indebted to Dr. Eustáquio Reis who enabled my stay at IPEA and provided many useful hints. Márcia Pimentel (IPEA) and Breno Pietracci (UFRJ) assisted in the computations. Interviews and consultations of a large number of people served as inputs to the present work: Gervásio Rezende, Steven Helfand, Ronaldo Serôa da Motta, Cláudio Ferraz and Bernadette Gutiérrez (all IPEA), Antonio Florido and Carlos Alberto Lauria (both IBGE), Sabina Campagnani and Eduardo Lardosa (IEF), Kenny Tanizaki (UERJ), Jean Dubois (Rebraf), Carlos Eduardo Young (UFRJ), Peter May (CPDA), Alfredo Homma (Embrapa, Belém), Patricia Shanley (Woodshole Research Center), Fabiana Issler (Roskilde University), Osmar Chevez Pozo (CPDA), Angelo dos Santos (FBDS), Pablo Rotta (Johnson Ceras, Rio), Edgar Gadelha (Johnson, Fortaleza) and Sibelle Alves (Copra). Additional calculations were made on request by IBGE (Denise de Medeiros). Information and consultancy reports presented at the 1st National Seminar on Forest Resources of the Atlantic Forest (São Paulo 30 June to 2 July 1999) were very useful sources. Useful comments were received at presentations at the Centre for Development Research, Copenhagen, on 16 June 1999, and in IPEA, Rio de Janeiro, on 30 July 1999. Project financing from the Danish Development Cooperation (Danida) is warmly appreciated.

pessimism [Browder (1992); Richards (1993); Coppen et alii (1994); Chomitz and Kumari (1998)].

The belief in the economic viability of non-wood extraction *vis-à-vis* converted land uses had been fortified by a number of pioneer, influential forest valuation and income generation studies from the Amazon, such as [see Peters et alii (1989), Anderson and Jardim (1989) and Anderson and Ioris (1992)]. It was thus sought to create an appropriate institutional framework for extractivism by promoting the land rights for traditional forest-extracting populations, such as indigenous groups and rubber tappers. Their social struggle was brought to the forefront of international attention with the assassination of the rubber tapper leader Chico Mendes. Extractivism also received international financing, culminating in the creation of the Resex project in the PP-G7 Pilot Program.

Consequently, there has been ample debate about the potential of extractivism as a tool for integrated conservation and development, but the economic-quantitative side of the issue has been somewhat under-researched. Homma (1993) provides a thorough analysis of Amazon extractivism, with a particular strength in the long-run historical analysis of different Amazonian products. Allegretti (1994) gives a static summary description of the extraction data in the 1980 IBGE Agricultural Census, but little analysis of the data. Two recent works by ISPN, Sawyer et alii (1997) and Pires and Scardua (1998) deal specifically with the Brazilian *cerrado* (savannah) region. The aforementioned studies by Peters et alii (1989) for the Peruvian Amazon, Anderson and Ioris (1992) for the Amazon estuary, and even Anderson et alii (1991) for the babassu production zone in Maranhão all represent case study settings which are perfectly justifiable in their own right. However, as will be argued below, they are by no means representative of the Amazon, or for tropical forests in a wider sense.

In the light of this panorama of existing research, the objective of the present paper is twofold. On the one hand, I will attempt to give a broader spatial overview of the economic size of extraction activities in the entire territory of Brazil, i.e. to map extractivism in a more general sense. On the other hand, specifically for the Brazilian Amazon region, I will seek to analyse the main determinants of extractive value generation: why are some extraction areas economically far more important than others, and what are their special characteristics? Why are some products widely cultivated, and others not? Are the same change factors at work for wood and non-wood products? What is the role of different types of soil and vegetation?

The main source used in the following is the Agricultural Census of the Brazilian Institute for Geography and Statistics (*Fundação Instituto Brasileiro de Geografia e Estatística*), which includes a questionnaire section about plant extraction. The latest census is from 1995/96, published in 1998 [see IBGE (1998*a*)], but selected data will be drawn from previous censuses, back to 1920. IBGE defines plant extraction as ‘the process of exploration of native plant resources which entails the harvesting or collection of products (....) either in a rational way that allows for a long-run sustainable off-take, or in a primitive and itinerant manner which generally allows for only one single production cycle' (IBGE 1998*a*:xi, my translation from Portuguese). The IBGE census also makes explicit reference to 'plant extraction (....) from non-planted (native) species'.[2] In parenthesis, this definition constitutes a notable change in terminology, for instance compared to the IBGE Statistical Yearbook from 1937 (p. 840), when "extractive production" simultaneous to rubber and coconuts made equal reference to the removal of steel, gold and salt!

By current definition, the origin of plant extractive production is thus native, natural vegetation, the main category of which is forests. Indeed, the main emphasis of this paper will be on extraction from natural forests. This is because this work is embedded into the two-year research project "The economics of non-wood forest benefits in Brazil", financed by the Danish Development Cooperation (Danida). This also means that the distinction of non-wood versus wood products will be central throughout the paper, with a special interest in the former, but without neglecting the latter category. The term "extraction" will be used for the economic activity that appropriates a physical value; the term "extractivism" will be used for the wider description of the mode and framework of this productive activity. Scientific plant names will be given when first mentioned in the text; subsequently the Portuguese or, when available, the translated English name of the plant and its products will be applied. Unless stated otherwise, values will be given in the current Brazilian currency *reais* (1 US$ = R$ 1.0051 in the census year 1996).

The structure of the paper is as follows. Section 2 presents and discusses the IBGE data — a controversial issue with key implications for the interpretation of results, which thus deserves a thorough treatment. Section 3 gives a description of extraction in all of Brazil, starting with identifying the thirty main products, turning then to the geographical distribution on Brazil's 27 federal states, and closing with inter-temporal trends. Section 4 provides a more detailed, spatial analysis for the Amazon region at the municipal level, with maps for the density of extraction values, and an econometric attempt at an explanation of the observed differences, using both economic and biophysical factors of explanation. Section 5 summarises the main points and discusses implications and perspectives. Three appendices and five text boxes further illuminate selected aspects and examples.

2 - THE DATA

The bulk of the following description and analysis is based on the recently published Agricultural Census 1995/96, and its predecessors, carried out by IBGE. This was the ninth census in the history of Brazil which contained a differing extent of information related to Brazilian agriculture; the previous one dates back

[2] The question is if the criteria of 'native' and 'non-planted' are fully over-lapping, for instance if species that are native for a particular region actually are planted.

to 1985. Data on current production, costs, income etc. refer to the period from 01-08-95 to 31-07-96; data on land area, ownership and employment to end-1995. Gross income from different types of production and products (annual and perennial crops, animal husbandry, plant extraction, forestry, processing activities) is registered. Cost elements are not dealt with on a product-specific basis, thus making it impossible to explicitly compare the profitability across different types of products and activities.

The unit of analysis in the census is the "agricultural establishment", producing any plant or animal output during the time span under analysis, be it a household or a firm, a farm owner or a tenant, a profit- or deficit-making unit, of rural or urban residence. The individual(s) interviewed refer to the one(s) that actually *manage* production, which may or may not be identical to the *owner* of capital and land — a tenant, sharecropper or farm administrator are some of the alternative. Census participation is mandatory so that, in principle, a total coverage is aimed at. 4.86 million establishments were interviewed in the 1995/96 census, which represents a notable 941,944 decline (16.2%) compared to the 1985 census. According to IBGE, this was partially caused by the change in the period of data collection (from the calendar to the harvest year), which reduced the participation of transitory producers, and thus the coverage of the census — [see IBGE (1998*a*, p. 35-42)].

A key question for the interpretation of the census results is thus to what extent marginal, forested areas and their inhabitants, from *caboclos* to *caiçaras* and inhabitants of indigenous reserves, are well represented in the census sample. If this is the case, another critical issue is the duration and quality of the interview, *vis-à-vis* different purposes of data collection. In general, 1-3 daily interviews per inquirer are carried out, including transport time, which indicates the limits for the normal range of time spent on each questionnaire. The census includes questions on all economic aspects of the establishment's farming system. Individual, fully structured interviews of the person "responsible for agricultural production" are usually carried out at the farm, although an overall assessment at the village level in some cases (e.g. indigenous communities) may be preferred.[3]

For the specific issue of plant extraction, production quantities during the last twelve months are inquired, according to the memory of the respondent. No pre-defined production area with a predictable productivity exists for extraction, so it may be difficult to cross-check the validity of the given information. Harvested and sold quantities are distinguished in the questionnaire, and a uniform price per quantity unit is applied to compute gross production values. The eight most common extraction products (both wood and non-wood) are pre-printed in the questionnaire; a supplementary list of 82 different plant extraction products is at the disposal of the inquirer, together with a detailed manual (IBGE, no date).

[3] A.C. Florido Simões, Head of IBGE's Agricultural Census Unit, personal communication, March 1999.

What are the comparative advantages and disadvantages of the Agricultural Census for an assessment of the economic values generated by plant extraction? The overwhelming advantage is the alleged full geographical coverage of the census, which should eliminate those sample representativity biases that are so common in the site selection and data interpretation of the literature on Amazonian non-timber forest products. Much investigation has been carried out in natural environments that are particularly favourable to high-value extraction, such as oligarchic forests or dense stands of palm trees producing commercial fruits. At the same time, the selected areas are often close to large urban markets, thus generating elevated per-hectare and per-household incomes that are not representative for rural areas in a broader sense. In comparison, the census should allow for a more generalised picture.

On the other hand, the large geographical coverage, combined with budget constraints,[4] jointly determine the main weaknesses of the census: a rapid, somewhat superficial assessment, which may not capture the full range of diverse uses in households living close to natural forests, not to speak of the intricate patterns of seasonal and yearly fluctuations characteristic for many plants in the wild. A head of a rural household cannot reasonably be expected to record *ex memoria* the consumption of, in principle, up to 82 extractive products over the last twelve months. In spite of the long list of products, certain uses (e.g. medicinal plants) are only sporadically represented in the product sample, and the true size of products with some economic importance is likely to be much larger.[5] Illegality of exploitation (e.g. of wood products in protected forests) may be an additional reason for (deliberate) understatement. The interview of only one household member may also imply that gender-specific extraction patterns are overlooked. In general, experiences with tropical forest valuation studies have shown that more sophisticated techniques (*in situ* observation, diaries, etc.) need to be employed, preferably over a longer time span, to give a more accurate picture [see Godoy et alii (1992) and Gregersen et alii (1995)].

One advantage of the census over other statistical sources is that it aims at a distinction of product origin between native, natural vegetation (extraction) and planted, cultivated resources (agriculture, animal husbandry, or plantation forestry). However, this also leaves some “grey”, intermediate areas of “soft management” techniques, which it may be difficult to classify correctly in an interview of reduced length. Some domestically consumed products, such as firewood, may originate from both planted and native resources. The use of popular plant names with many local variations may lead to confusions when the

[4] Cuts in IBGE’s budgets increased between 1985 and 1995/96, which may have affected both the quantity (coverage) and quality (time for each questionnaire) of the census data.

[5] IBGE published in 1996 an electronic version of the Cadastre of Plant Species of Economic Importance [IBGE (1996)]. It is indicative that this register contained no less than 3,512 species. However, the question is how many of these huge number of species actually provides a significant economic value. See discussion in Section 2.

same plant is identified by various names, or *vice versa*.[6] Also, the census does not distinguish product origin in terms of different biomes. This means that products collected from non-forest native vegetation forms are also included. In particular, it is important to note the case of a relatively large range of products that fully or partially are extracted from the Brazilian savannah (*cerrado*), including from the transition zones between forest and *cerrado*, such as some semi-deciduous forests.[7]

The agents and harvesting areas included in the Census may imply additional omissions. Some products may actually not be harvested by a "rural establishment", but rather by landless workers that are employed by those establishments. Case study examples in this regard are *pequi* nuts (*Caryocar brasiliense*) harvested in Minas Gerais State (O.Chevez Pozo, pers.comm.), or Brazil nuts (*Bertholletia excelsis*) collected by land-clearing workers in Pará state [see Clay (1997*a*, p. 256)]. Related to this is the question of land tenure. The Census should, in principle, only count those products that are harvested from the area owned, leased or occupied by the individual establishment, but not those that come from state lands or other open-access areas. In practice, many of the non-timber forest products registered in the Census are likely to be harvested from open-access areas outside the proper establishments; again, Brazil nuts are a good example (*ibid*, p. 252-255).

Furthermore, and perhaps most important, the Census is generally confined to plant resources so that, in terms of an interpretation towards total non-timber forest extraction values, the non-registration of game constitutes a severe limitation for some geographic areas.[8] Consequently, both the range and quantities of plant extraction are likely to be underestimated in the census especially in those regions where multi-product extraction for auto-consumption is pre-dominating. Having said that, it should be noted that some of the most common subsistence products are in fact registered in the census data, such as firewood and wood posts (86% for domestic consumption, respectively), or a non-wood product like buriti palm fruits (*Mauritia flexuosa* L. — 93% own consumption).[9]

However, a bias of the opposite sign applies to prices, where an overestimation of extraction values occurs. The census registers just one set of (market-derived) prices, to be applied both to auto-consumption and to product sales. First, this leaves an open question as to what valuation technique was applied for auto-consumption products where there was no local market, as occurs in some

[6] Pires and Scardua (1998) mention the case of "pequi", covering two different species in the central savannas and in the northeastern state of Ceará, respectively.

[7] According to the work of Pires and Scardua (1998, p. 47-72), this concerns products from plants such as carnauba (*Copernicia cerifera* Mart.), buriti (*Mauritia flexuosa* L.), mangaba (*Hancornia speciosa Gomez*), urucum (*Bixa Orellana* L.), copaiba (*Copaifera martii Hayne*), babassu (*Orbygnia* Mart.) and pequi (*Caryocar brasiliense*).

[8] In the overview of tropical forest valuation studies provided by Godoy et alii (1993, p. 226-227), some of the studies are exclusively based on game off-take.

[9] See Table 1 for a more complete picture of commercial uses versus auto-consumption.

locations for firewood, wood poles, locally abundant fruits, etc. Secondly, even in the presence of such markets, commercialised products will often be of a superior quality, compared to the ones that are consumed directly at the site.[10] Thirdly, and most important, any transaction-based price from farm-gate prices to urban consumer prices may be used in the questionnaire, but the difference between the two extremes may be extensive, due to the inclusion of transport costs and middlemen profits in the latter. Only farm-gate prices truly reflect the value to the specific rural productive establishment. Applying village or, at worst, urban product prices may result in a significant over-estimation of auto-consumption uses: many natural forest products currently consumed in remote areas would be so costly to bring to urban markets that their commercialisation would yield net losses. Often, this is exactly why their marketing does not occur, in spite of their local abundance.[11]

Finally, it should be noticed that other statistical sources in Brazil also assess plant extraction values, but they do generally not provide attractive alternatives for our research purposes. IBGE also publishes the annual survey PEV (Produção da Extração Vegetal); since the mid-1980s, the survey has been renamed PEVS (Produção da Extração Vegetal e da Silvicultura) because it pools extraction and plantation forestry data. Unfortunately, this means that it becomes impossible to distinguish between a native and a plantation forest origin of the respective product. The latest PEVS version covers data for 1995, with a three-year publication lag [see IBGE (1998)]. The survey always uses the latest available census (here, from 1985) as a base, and projects changes on the basis of a network of variable types of informants at the municipal level (*ibid*, p. xi). It thus does not represent a set of primary data, but rather individual experts' "best guess" or subjective observations on local market trends. Obviously, data origin makes the annual survey an inferior type of source, compared to the more direct and objective information collected in the census. Furthermore, abrupt and inexplicable year-to-year changes occur, possibly because of discontinuities in the type of informants. As will be shown below, the highly fluctuating character of most non-wood markets over time makes the PEVS a little reliable source in assessing extraction quantities.

[10] Firewood is a classical case, where often only the most dense energy-rich species are marketed.

[11] Exceptionally, the opposite case may apply, requiring a more 'offensive' valuation. Products with a strategic role for household's livelihood (e.g. certain medicinal plants), derived from threatened habitats (e.g. forest remnants), would need to be valued by their auto-consumption value, e.g. by the price of a synthetic medicine purchased in an urban market, *plus* the costs of transport and time necessary to bring the product to the peripheral household. This indicates some of the methodological difficulties related to the valuation of forest-dwelling households' subsistence-oriented forest extraction, requiring a case-by-case assessment of the relative product abundance and opportunity costs of extraction.

3 - PLANT EXTRACTIVISM IN BRAZIL

3.1 - Main Products

In spite of the presence of plant extraction activities in most of Brazil, much of the research around non-wood products has been concentrated in the Amazon region. For this reason, the purpose of the present section is to give an overall description of plant extraction patterns in the entire territory of Brazil. Table 1 summarises the extraction quantities and values of the 30 main items, out of all the total 82 products that are registered in the IBGE Census.

The top-three products of the list are the three principal wood products: firewood (primarily for auto-consumption), lumber and charcoal (both primarily for sales). The three products exhibit a quite different user profile: Whereas the number of firewood-collecting establishments exceeds 1.5 million, the extraction of charcoal and especially timber is much more concentrated, the latter being generated by only 44,960 respondents.[12] Together, these three products accounted for a gross value of R$ 540.2 million, or 72% of total plant extraction values, during the twelve-month census period of 1995/96. It is thus an important observation *per se* that when we talk about plant extraction and extractivism in Brazil, almost three fourths of the value is derived from wood products.

The three largest non-wood products are next in the ranking, almost equal in the size of their production value. The largest, babassu almonds (R$ 38.6 million), originates from the babassu palm (*babaçu, Orbygnia martiana*), and its oil-rich seeds are utilised for a variety of uses such as cooking, soap-making, burning etc. The seeds of the kernel are processed into flour, babassu milk and animal feed, used in medicines, beverages etc. [see Anderson et alii (1991)]. The palm occurs mainly in oligarchic forests with dense, often almost homogeneous stands, covering about 29 million ha [see Peters (1996, p. 18)], in the Southern and Eastern fringes of Amazonia, mainly in states of Maranhão, Piauí and Tocantins. Basically all of harvesting occurs from natural stands. During the last decade, however, babassu oil has lost market shares to cultivated, cheaper palm oils, both in the domestic and export markets (E. Gadelha and S. Alves, pers.comm.). The census data in Table 1 indicates a highly commercial orientation of kernel extraction, with 93% of the production quantity being sold, a number which is confirmed by solid case-study evidence from Maranhão state.[13]

[12] For all three wood products, it should be remembered that alternative production from planted trees (*silvicultura*) exists, whereas the present figures only refer to extraction from natural vegetation.

[13] Anderson et alii (1991, p. 111-121) found in their study of the babassu zone of Maranhão state that around 95% of babassu kernels are sold, while 5% are consumed domestically. A larger subsistence income is derived from babassu side-products, mainly charcoal-making from the endocarp for a weekly domestic consumption of, on average, 10 kg per household, making up about 4% of total income, and about 17% of all babassu-derived income (*ibid*, p. 113-114). However, this energy use value is in the census counted under the category of “charcoal”.

Table 1

30 main plant extraction products in Brazil, 1995/96

Product	No. of fed. states	Number of respondents	Quantity extracted (in Kg)	Quantity sold (in Kg)	Quantity sold/ extracted (in %)	Production value 95/96 (in millions R$)	Average extraction value (R$) per respondent	Annual survey value 1995 (in millions R$)
Firewood	27	1.524.767	425.59.582 [1]	6.070.817 [1]	14,3	205,587	135	n.a.
Lumber	26	44.960	11.925.797 [1]	10.309.814 [1]	86,4	202,742	4.509	n.a.
Charcoal	27	245.814	1.231.931.006	1.060.115.466	86,1	131,895	537	n.a.
Babassu almond	14	127.468	126.851.566	117.904.868	92,9	38,568	303	26,318
Maté tea	10	38.929	206.593.747	196.725.504	95,2	35,053	900	n.a.
Cabbage palm fruit	13	39.689	151.886.359	91.476.576	60,2	34,993	882	35,075
Wood stakes	26	26.426	27.779.889 [2]	7.024.339 [2]	25,3	14,890	563	n.a.
Piassava fibres	7	2.401	18.209.153	18.133.706	99,6	13,730	5.718	62,053
Cabbage palm hearts	18	10.804	86.080.261	83.755.970	97,3	13,203	1.222	10,616
Hevea coagulated	13	7.585	8.404.647	8.272.952	98,4	6,945	916	8,994
Carnauba powder	9	5.191	7.008.082	6.577.698	93,9	6,794	1.309	19,579
Brazil nuts	19	14.767	19.300.521	18.133.533	94,0	5,718	387	8,853
Wood poles	18	3.723	1.604.604 [2]	232.357 [2]	14,5	2,988	803	n.a.
Wood posts	19	4.278	1.349.241 [2]	414.095 [2]	30,7	2,795	653	n.a.
Wood sticks	26	9.093	2.760.633 [2]	894.359 [2]	32,4	2,705	298	n.a.
Carnauba wax	13	1.874	5.855.678	3.811.855	65,1	2,662	1.421	13,481
Ciruella	11	13.665	8.872.610	3.250.927	36,6	1,973	144	n.a.
Carnauba dried	8	1.613	13.223.721	9.731.349	73,6	1,756	1.089	n.a.
Pine seed	11	5.992	3.055.093	2.525.798	82,7	1,632	272	n.a.
Carnauba oil	7	2.117	2.772.001	2.525.798	88,9	1,427	674	n.a.
Pequi nuts (Caryocar)	12	3.608	4.289.113	2.798.644	65,2	0,991	275	0,695
Bacury fruit	11	2.174	7.654.324 [2]	4.823.020 [2]	63,0	0,835	384	n.a.
Mangaba fruit (Apaninacea)	14	1.645	2.320.529	1.616.267	69,7	0,829	504	n.a.
Cupuaçu fruit	11	4.187	979.766 [2]	707.514 [2]	72,2	0,766	183	n.a.
Wood beams	20	414	467.619 [2]	98.090 [2]	21,0	0,755	1.823	n.a.
Timbó (woody vine)	13	546	1.439.146	1.380.819	95,9	0,734	1.344	n.a.
Buriti (wine-palm fruit)	15	5.030	4.910.966	319.574	6,5	0,680	135	0,068
Mallow fibres	3	646	1.381.208	1.379.130	99,8	0,573	887	n.a.
Murici (Byrsonima)	14	2.137	2.983.444	2.846.128	95,4	0,529	248	n.a.
Bamboo	16	1.255	500.719 [1]	374.019 [1]	74,7	0,461	368	n.a.
Total (30 main products)						735,211		
Total extraction value (all products)						754,213		

Source: Own calculation based on IBGE, Agricultural Census 1995/96; IBGE Annual Survey of Plant Extraction and Silviculture.

Notes: [1] *In* m^3.

[2] *In units.*

A similar highly commercial orientation is found for the second product on the list of non-wood extraction, maté tea (*erva-mate, Ilex paraguariensis*). Its commercialisation share amounts to 95%, out of a yearly production value of R$ 35.1 million. Maté grows preferably in the *Araucaria* forests of the three southern Brazilian states, Paraná, Mato Grosso do Sul and Santa Catarina, as well as in Uruguay, Paraguay and northern Argentina. The leaves from the bush-like plant are harvested twice a year and its main use, originally taken over from the Amerindians, is as a hot tea (*chimarrão*), though the plant is also processed for cold refreshments, extractive fluids, essential oils, medicines, cosmetics, etc. [see Andrade (1998)]. The total production area in Brazil is estimated at 450,000 km^2, which comprises both extraction from natural forests and maté plantations. Even in 1939, 32% of the about 80,000 tons of yearly production was already cultivated [see IBGE (1950, p. 71)]; today, this share has risen moderately to 43%, but out of a total production that has increased more than fourfold.

The value of maté exports (mainly to Uruguay[14]) was in 1997 US$ 32.2 million. This would seem extremely large, compared to the extraction value in Table 1, but the difference is basically due to value added: exports consist now almost exclusively of processed maté, which commands a price that rises sevenfold, compared to the produces price of the harvested leaves [see Andrade (1998, p. 38)]. In general, the considerable price gap between raw and elaborated products is noteworthy, especially *vis-à-vis* popularised sources that erroneously attribute the full value-added to the natural biome of origin.[15] Normally, it is (a portion of) the product's *farm-gate price*, not the urban consumer price, which is indicative of the resource rents generated at the forest level.[16]

The fruits of the cabbage palm, also called assai palm (*açaí, Euterpe oleracea, Mart.*) occupy the sixth position, with a yearly gross production value of R$ 35.0 million. In addition, the palm can also be utilised for the harvesting of palm hearts (see Box 1). With R$ 13.2 million, this use occupies the ninth position on the list of all extracted products. The combined harvest value of R$ 48.2 million from the cabbage palm thus constitutes the single most important contribution to the value of non-wood products in Brazil. The cabbage palm is an Amazonian tree, one type of which grows in *terra firme* (*Euterpe precatoria* Maritus), at about 2-3 trees per ha [see FAO (1986, p. 137)]. Yet, the variety of *Euterpe Olerácea* Maritus is much more abundant, and grows in riverside systems like *várzea, igapó* and estuary environments. In the estuary around the largest city of the Amazon basin, Belém (Pará state), extremely dense stands of cabbage palms can be found, with about 4,000 to 7,000 trunks per ha [see FAO (1986, p. 133)]. Here, the almost

[14] Much of the maté exports to Uruguay is destined for re-exports to third countries, indicating that the network of international commercialisation is more elaborated in Uruguay (D. da Croce, pers.comm., São Paulo 1 July 1999).
[15] For instance, the journal article 'Millions of *reais* in the forest resources of the Atlantic Forest', *Gazeta Mercantil*, 6 July 1999, where different aggregate value (incl. from cultivated resources) are attributed to the remnants of the Atlantic forest.
[16] For instance, in the case of timber, this 'pure' resource rent would be represented by stumpage values.

uniform stands, combined with the closeness to Belém, make the harvesting of assai fruits extremely profitable.[17] Fruits are then processed into pulp (for drinks, ice cream, liquors, etc.), and to 'assai wine' — a product of basic nutritional value that is very popular in the Amazon region.[18] The importance for auto-consumption uses is underlined by the fact that 40% of the fruits are used domestically (for palm hearts, the figure is less than 3%).

BOX 1

MULTIPLE PRODUCT MANAGEMENT: EXTRACTION FROM CABBAGE PALMS

In principle, cabbage palms can be managed simultaneously for both fruit and palm heart (*palmito*) extraction: selective pruning of the stems both enhances fruit production and provides palm hearts. However, specialisation of management systems tends to occur, and management for fruit production is generally the most profitable alternative [see Nogueira and Homma (1998)]. Whereas fruit-oriented multi-product management indeed occurs in the vicinity of large markets, exclusive harvesting of palm hearts is found in market-distant areas. Here, the highly perishable character of the fruit impedes commercialisation at any significant scale: If the time between harvesting and processing of the fruit exceeds 24 hours, fermentation occurs [see Nogueira et alii (1995, p. 35)]. The processed "assai wine" can only be stored for 12 hours before consumption [Sebrae (1995, p. 9)]. Extraction of cabbage palm hearts took off in the 1970s, following the progressively destructive harvesting of the one-stemmed *juçara* palm (*Euterpe edulis* Mart.) in the Atlantic forests. Resource exhaustion made many industries move north, in order to exploit the vast potential of Amazonian palms. Compared to *Euterpe edulis*, the cabbage palm's multi-stemmed form facilitates a sustainable use, making this a technically feasible option [see Clay (1997*b*)]. But, as shown in a case study of the palm heart industries on Marajó Island (Pará state, north of Belém), over-harvesting of stems with declining palm size and production quantities over time is the general rule [see Pollak et alii (1995)]. Apparently, this results from a combination of factors: higher labour costs related to sustainable management, the (still) prevalent perception of resource abundance, a short-term horizon of investors, and quasi open-access to the land for collection [*ibid.* Nogueira and Homma (1998)].

Following in the ranking of Table 1 is wood stakes, a product mostly used by cattle ranchers directly at the farm (only 25% of the volume is commercialised). The next most important non-wood product is piassava fibres (*piaçaba*, *Attalea funifera* Mart.), with a production value of R$ 13.7 million. The harvesting of this palm product, used e.g. in the manufacture of brooms and brushes, is concentrated in the north-eastern federal state of Bahia (63% of production value), especially the *restinga* forests that constitute what has been called the 'Brazilian fibre belt' [see Voeks (1986)]. A different type of piassava (*Leopoldinia*) is found in the state of Amazonas (37% of national production);[19] in fact it constitutes the economically most important non-wood product in this state. Secondary uses of piassava include fruits and palm hearts. The palm is highly fire-resistant, so that it thrives on frequently burnt lands, often naturally poor or degraded soils, where it becomes the dominating tree species [see Voeks (1986, p. 254)]. "Pure"

[17] On the island of Combu, in the vicinity of Belém, Anderson and Ioris (1992) found a yearly average household income of more than US$ 4,000 from the harvesting of assai fruits.

[18] It is estimated that the consumption of assai wine in Belém reaches an average of 180,000 liters per day [see Sebrae (1995)].

[19] L.A. Mattos, pers.comm., São Paulo, 30 June 1999.

extractivism occurs, i.e. without management and from diverse natural forests and other natural vegetation types, but often fire is used as an active management tool to eliminate competitive vegetation. Piassava can here be combined with pastures, and yields are notably higher in these modified ecosystems than inside the forest; at present, insect attacks and other technical problems have impeded proper cultivation of the palm (L.A. Mattos, pers.comm., 30 June 1999, São Paulo). The predominantly large-scale character of production on *fazendas* implies that the number of respondent extractors in Table 1 is rather low (2,401), compared to the size of gross revenues. Piassava thus holds the highest average extraction value per respondent (R$ 5,718) of all the thirty main products in Table 1. Until the 1970s, it was an important export product, but was then substituted by other natural sources and by synthetic fibres, so that its dynamics lately have been derived from the domestic market.

Carnauba (carnaúba, *Copernicia cerifera* Martius) is another important commercial palm tree, but flourishing in the semi-arid zones of northeastern Brazil (mainly in the States of Ceará, Piauí, and Rio Grande do Norte).[20] The ecology of carnauba bears some resemblance to piassava and to other palms: its resistance to both fire and droughts make it a successful pioneer plant, which may grow in dense uniform stands, but seldom in more biologically diverse forests (see Box 2). Its main use is oleaginous: a wax is derived from its cut, dried and processed leaves. Other, minor uses relate to its wood, fibres, palm hearts and fruits (for human and animal alimentation). Young palm trees have a lower productivity, but yield a higher quality of powder (*pó-de-olho*) than the leaves harvested from older palm trees (*pó-de-palha*). Four different categories of sub-products are distinguished in the census, with a combined current value of R$ 12.6 million.

Traditionally, carnauba has constituted one of the most important export products from the Brazilian Northeast [BNB (1970)]. A large share of exports goes to the US, where industrial wax uses are extremely diversified: for polishing (cars, furniture, etc.), pharmaceutics (capsules, tablets), cosmetics (lipsticks), carbon paper, films, dyes, varnishes, electronics (isolators etc.) and foodstuffs (chocolates, sweets, etc.). Brazil is the only producer of carnauba. Only one natural substitute seems to exist (the Candelila palm wax in Mexico), but various synthetic substitutes are in constant development, although they are not applicable to all the mentioned industries. Lately, world market consumption has remained static, at about 14,000 to 16,000 tons a year (E. Gadelha, pers.comm.).

[20] Carnauba also occurs in many other parts of Brazil, but not at the same density and with the same wax production per plant as in the *Nordeste*.

BOX 2
DENSE NATURAL STANDS AS "QUASI-PLANTATIONS": THE CASE OF CARNAUBA

Since the 1860s, experiments have been carried out to establish carnauba plantations, but as Joaquim Carvalho noted already back in the 1940s, no significant success in "rationalising the use of carnauba" had been made [see Carvalho (1942, p.131)]. The same author notes that carnauba may dominate landscapes with extremely dense stands and high frequencies, but "only accidentally will a carnauba palm tree appear inside the forest" — "forest" understood by him as a biologically more diverse system (*ibid*, p. 65). In the mid-1960s, a small amount of carnauba plantations had been established in the main producer State of Ceará [see Guimarães (1966, p. 12)]. However, in the Census of 1995/96, all production has been registered under plant extractivism. Given the regional economic importance of the palm, why has there be no major push towards plantation, as for instance has occurred in the case of another product from the northeast, cashew (see Box 4)? The answer lies in the economic sphere. Carnauba is a relatively slow-growing species, requiring 20 years from planting to sizeable production; a capital outlay with highly lagged returns [see Guimarães (1966)]. Secondly, it does not compete well with alternative land uses: per-hectare returns are low, implying that carnauba has increasingly been relegated to areas of inferior agricultural potential, often occupying saline, poorly drained soils [see Lorenzi et alii (1996, p. 79)]. However, in these areas, carnauba is highly abundant, compared to the rather static world market demand (E. Gadelha, pers.comm.). Just as in the case of piassava, natural regrowth combined with simple management techniques, including the use of fire, secure the main benefit from plantations, even within natural stands: a high density of commercial plants. This reduces management, harvesting and transport costs. As long as there is plentiful of under-utilised land available, there seems to be no strong economic justification to invest heavily in R & D for the development of sophisticated, land-intensive and quality-improving cultivation techniques. One may conjecture that the only factor to change this picture would be a strong rise in external demand. In this case, extractive supplies alone would probably become deficient, providing ample monetary rewards for R & D, land intensification, homogenisation and quality improvement — approximately the scenario that has been observed for cashew.

Perhaps somewhat surprisingly, products that traditionally are associated with extractivism — and specifically with the concept of extractive reserves — such as tree-tapped rubber (*Hevea brasiliensis,* coagulated or as latex) and Brazil nuts (*castanha-do-Brasil* or *castanha-do-Pará, Bertholletia excelsa*), are not among the top-earners of gross extraction income at the national scale. Both of them, though, are leading products in some federal states of Brazil (see below). With R$ 6.9 million, coagulated rubber occupies the tenth position;[21] Brazil nuts earn R$ 5.7 million (12th position), the combined value being inferior to that of piassava. In general, the concentration of extractivist income on few products in Table 1 is noteworthy: all 82 products generate a value of R$ 754 million production, of which the top-thirty account for 97% and the top-six for 86%.

3.2 - Geographical Distribution

Is the high concentration on products also reflected in a corresponding geographical distribution of extraction values? Table 2 shows the disaggregated plant extraction data for Brazil's 27 federal states, summing up the wood and non-

[21] Combined with the value of latex milk (not among the 30 principal products), the extraction value of hevea is R$ 7.2 million.

wood product categories, respectively. For the non-wood group, six additional subgroups are distinguished: foodstuff, teas & medicines, rubbers, non-elastic gums, fibres and oils & waxes. The categories have been selected so as to allow for a comparison with Allegretti (1994, p. 22-28), who gives a description of the corresponding 1980 census data. At the national scale (last column in Table 2), one can see that total non-timber extraction value amounts to R$ 189.5 million in 1995/96, but more than half (R$ 99 million; 52.2%) is made up by food products, including fruits as the most important items. Oils and waxes account for R$ 65.2 million (34.4%), whereas the four other subgroups only yield a combined value of R$ 25.3 million (13.4%).

Allegretti's data are in US$, which due to the exchange rate policy of the period (US$ 1 = R$ 1.0051 by end-1996) are almost directly comparable to the values in *reais* (R$) from Table 2. For the first two sub-groups (food, teas, medicines), value has fallen from 1980 to 1995/96, from US$ 120.2 to US$ 99.3 million; there has been a decline for cashew and Brazil nuts. For rubbers and non-elastic gums (groups 3 and 4), the fall is more dramatic: from US$ 45.3 to US$ 8.0 million. This is mainly due to the demand collapse for *Hevea* coagulated, which alone declines from US$ 39.5 to US$ 6.9 million [Allegretti (1994, p. 25 and Table 1)], due to growing cultivation inside of Brazil, as well as increasing natural and synthetic substitutes abroad. For fibres, the value is basically unchanged: US$ 16.3 versus US$ 17.0 million. For oils and waxes, there has been a decline from US$ 78.7 to US$ 64.9 million, which specifically has to do with a certain decline in the sales of babassu. The combined 1980 value of all non-wood products listed by Allegretti is US$ 260.8 million, compared to US$ 188.6 million in 1995/96. In spite of the high-valued Brazilian currency in 1996, the dollar value of non-wood extraction has thus declined by at least 28% over the period of fifteen years.[22] However, the value of top-three wood products (lumber, charcoal, firewood) fell even more dramatically, from US$1,478 million in 1980 to only US$ 540 million in 1995/96 (63% down), a reduction that is particularly strong for lumber and firewood.

Returning to the geographical distribution in Table 2, we may first have a look at the territory of Legal Amazonia (*Amazônia Legal*), distributed on nine different federal states.[23] In the small western Amazonian states of Acre and Rondônia, rubber is by far the main non-wood product (70.5% and 78.7% of non-wood value, respectively); in Acre, it is even the most important overall extractivist product. Rubber is also the predominant non-wood product in neighbouring Mato Grosso, but in this state its role is totally over-shadowed by lumber extraction.

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[22] Allegretti's figures are underestimating total non-wood values because only the 20 most important products are considered. However, if product concentration was as marked in 1980 as in 1995/96 (where the top-twenty products make up 96.6% of total value), this should only be a minor consideration.

[23] Acre, Rondônia, Amazonas, Roraima, Pará, Amapá, Tocantins, Mato Grosso, and most of Maranhão State.

Table 2

Group of wood and non-wood extractivist products in Brazil values by federal states, 1995/96

(In R$)

Group	Federal state							
	Rondônia	Acre	Amazonas	Roraima	Pará	Amapá	Tocantins	Mato Grosso
1. Food products	131.802	708.752	3.112.309	85.324	48.976.175	1.037.440	34.530	48.573
2. Teas, medicines, etc.	900	5.604	278.311	-	94.066	-	540	-
3. Rubbers	444.123	2.865.545	1.891.545	-	183.466	-	20.975	225.422
4. Non-elastic gums	-	-	8.430	-	230.246	-	525	8.820
5. Fibres	3.827	-	5.118.768	1.150	590.537	-	-	17.675
6. Oils, waxes, etc.	32.280	8.055	625.553	12.555	11.221.462	14.965	1.346.036	24.296
Total non-wood	*612.931*	*3.587.956*	*11.034.915*	*99.029*	*61.295.952*	*1.052.405*	*1.402.606*	*324.786*
Principal non-wood product in each state								
Product name	Hevea coagulated	Hevea coagulated	Piassava fibres	Brazil nuts	Cabbage palm fruit	Brazil nuts	Babassu almond	Hevea coagulated
Value extracted	432.040	2.824.057	5.073.863	20.949	32.105.104	503.313	1.336.288	215.422
Share in total non-wood extraction	70,5%	78,7%	46,0%	21,2%	52,4%	47,8%	95,3%	66,3%
7. Wood products	8.724.407	2.694.624	21.880.792	1.246.496	127.607.204	2.875.472	6.472.186	42.695.284
Total extraction	*9.337.338*	*6.282.580*	*32.915.707*	*1.345.525*	*188.903.156*	*3.927.877*	*7.874.793*	*43.020.069*
Principal extractivist product in each state								
Product name	Lumber	Hevea coagulated	Firewood	Firewood	Lumber	Lumber	Firewood	Lumber
Value extracted	5.234.181	2.824.057	10.418.559	438.563	96.276.044	2.533.002	3.061.404	38.757.002
Share in total extraction	56,1%	45,0%	31,7%	32,6%	51,0%	64,5%	38,9%	90,1%
Total non-wood as a percentage of total extraction value	6,6%	57,1%	33,5%	7,4%	32,4%	26,8%	17,8%	0,8%

(continue)

(continued)

Group	Federal state							
	Maranhão	Piauí	Ceará	Rio Grande do Norte	Paraíba	Pernambuco	Alagoas	Sergipe
1. Food products	2.850.191	548.474	439.866	519.414	453.885	414.224	22.715	287.814
2. Teas, medicines, etc.	39.683	241.957	168.111	1.228	88	1.008	-	-
3. Rubbers	171.163	3.169	534	-	-	49.630	-	-
4. Non-elastic gums	2.277	-	175	-	-	255	-	24
5. Fibres	327.420	159.489	1.349.130	57.566	23.413	14.726	1.100	100
6. Oils, waxes, etc	35.407.781	7.401.373	5.684.473	585.625	94.081	281.518	2.333	37.186
Total non-wood	*38.798.514*	*8.354.463*	*7.642.288*	*1.163.832*	*571.467*	*761.360*	*26.148*	*325.124*
Principal non-wood product in each state								
Product name	Babassu almond	Carnauba powder	Carnauba powder	Mangaba fruit	Ciruella	Ciruella	Cashew fruit	Mangaba fruit
Value extracted	34.643.835	3.670.493	2.654.045	437.240	405.348	295.197	7.013	263.770
Share in total non-wood extraction	89,3%	43,9%	34,7%	37,6%	70,9%	38,8%	26,8%	81,1%
7. Wood products	41.279.460	11.904.917	23.605.757	3.483.197	5.834.365	8.064.928	725.380	1.949.170
Total extraction	*80.077.974*	*20.259.380*	*31.248.045*	*4.647.029*	*6.405.832*	*8.826.289*	*751.528*	*2.274.294*
Principal extractivist product in each state								
Product name	Babassu almond	Firewood	Firewood	Firewood	Firewood	Firewood	Lumber	Firewood
Value extracted	34.643.835	4.913.667	16.509.516	2.680.135	3.616.828	4.817.595	256.236	1.655.142
Share in total extraction	43,3%	24,3%	52,8%	57,7%	56,5%	54,6%	34,1%	72,8%
Total non-wood as a percentage of total extraction value	48,5%	41,2%	24,5%	25,0%	8,9%	8,6%	3,5%	14,3%

(continue)

(continued)

Group	Federal state					
	Bahia	Minas Gerais	Espírito Santo	Rio de Janeiro	São Paulo	Paraná
1. Food products	1.762.400	672.365	6.564	2.680	21.048	19.147.704
2. Teas, medicines, etc.	9.390	1.187	171	-	450	50
3. Rubbers	1.010.925	128.675	66.044	-	152.493	519
4. Non-elastic gums	1.367	-	300	-	-	155
5. Fibres	9.033.090	25.883	760	24.137	174.984	108.700
6. Oils, waxes, etc.	1.074.280	284.593	30.300	1.240	403.953	151.634
Total non-wood	*12.891.454*	*1.112.703*	*104.139*	*28.057*	*752.929*	*19.408.762*
Principal non-wood product in each state						
Product name	Piassava fibers	Pequi nuts	Hevea coagulated	Bamboo	Resins	Maté tea
Value extracted	8.637.549	379.696	66.044	24.087	301.609	18.894.819
Share in total non-wood extraction	67,0%	34,1%	63,4%	85,8%	40,1%	97,4%
7. Wood products	45.762.780	75.508.083	5.554.650	170.155	3.158.386	39.011.099
Total extraction	*58.654.234*	*76.620.787*	*5.658.789*	*198.212*	*3.911.315*	*58.419.861*
Principal extractivist product in each state						
Product name	Firewood	Charcoal	Charcoal	Firewood	Firewood	Maté tea
Value extracted	20.289.574	46.548.363	4.535.355	143.588	1.643.817	18.894.819
Share in total extraction	34,6%	60,8%	80,1%	72,4%	42,0%	32,3%
Total non-wood as a percentage of total extraction value	22,0%	1,5%	1,8%	14,2%	19,3%	33,2%

(continue)

(continued)

Group	Federal state					
	Santa Catarina	Rio Grande do Sul	Mato Grosso do Sul	Goiás	Brasília (DF)	*BRAZIL*
1. Food products	12.067.424	4.993.995	553.239	93.966	-	99,0
2. Teas, medicines, etc	-	3.906	-	-	-	0,8
3. Rubbers	-	568	-	-	-	7,2
4. Non-elastic gums	-	300	-	-	-	0,3
5. Fibres	4.531	75.741	-	580	-	17,1
6. Oils, waxes, etc.	361.332	126.006	1.545	12.847	-	65,2
Total Non-wood	*12.433.287*	*5.200.516*	*554.784*	*107.393*	-	*189,6*
Principal non-wood product in each state						
Product name	Maté tea	Maté tea	Maté tea	Pequi nuts		Babassu almond
Value extracted	10.967.410	4.632.334	553.207	52.628	-	38,5
Share in total non-wood extraction	88,2%	89,1%	99,7%	49,0%		20,3%
7. Wood products	27.754.690	36.230.792	7.710.939	12.657.729	1.924	564,6
Total extraction	*40.187.977*	*41.431.309*	*8.265.723*	*12.765.122*	*1.924*	*754,2*
Principal extractivist product in each state						
Product name	Firewood	Firewood	Charcoal	Charcoal	Charcoal	Firewood
Value extracted	19.360.984	33.278.053	4.618.255	6.032.425	1.920	205,5
Share in total extraction	48,2%	80,3%	55,9%	47,3%	99,8%	27,2%
Total non-wood as a percentage of total extraction value	30,9%	12,6%	6,7%	0,8%	0,0%	25,1%

In the large, northern state of Amazonas, there is a more equal distribution on mainly foodstuff, rubbers and fibres, although piassava makes up almost half of the non-wood value. As in the other northern state, Roraima, firewood is the most important extractivist product. In the eastern Amazon, Pará State holds by far the largest extraction value in Brazil of both non-wood (more than R$ 60 million; cabbage palm fruits are dominant) and wood products (Pará is responsible for about half of the national timber extraction). In both Amapá and Roraima, Brazil nuts head the list of non-wood products. Turning towards north-eastern Brazil, the babassu belt is strongly reflected in the statistics (Tocantins and, particularly, Maranhão), occupying 95.3% and 89.3% of non-wood production, respectively.

Most forests in the drier areas of north-eastern Brazil make part of the Atlantic forest biome, concerning the federal states of Ceará, Rio Grande do Norte, Piauí, Paraíba, Pernambuco, Alagoas and Sergipe, but most of these forests have over time become highly fragmented, and subject to reiterative degradation. In this area, extraction has in general a more limited role to play than in the eastern Amazon, and is clearly dominated by energy demand (consumption of firewood): in five of the seven states, firewood makes up more than 50% of gross extraction income. Different fruits (mangaba, ciruella, cashew) are, together with carnauba, the most important non-wood products. As mentioned, the large state of Bahia is the stronghold of piassava fibre production, making up 67% of the state’s non-wood production.

In south-eastern Brazil, the largest and most continuous tracts of Atlantic forest can be found, supplemented by a large number of forest fragments. This zone holds the industrial centres of the states of São Paulo, Rio de Janeiro and Minas Gerais. Historically, in a country not endowed with rich hydrocarbon energy resources, the industrial demand for wood energy (firewood, charcoal) has played a significant role in promoting regional deforestation, especially concerning the use of charcoal in the metallurgic industry of Minas Gerais. Although significant substitution to plantation-derived wood and other energy sources has occurred, this is still reflected in the census figures: charcoal is the main extraction product in both Minas Gerais (R$ 46.5 million) and Espírito Santo (R$ 4.5 million). The registered value of non-wood forest extraction in the south-east is minimal, and figures do not represent reliable estimates, often related to the illegality of ongoing extraction (see Box 3). On the other hand, the low non-wood values, compared to other parts of Brazil, are not exclusively a statistical “mirage”, but also reflect a touch of reality. High urbanisation (with a large population share concentrated in tertiary sectors) reduces product extraction from forests. This is reinforced by higher political emphasis on forest protection, and the less “specialised” character of natural forests, with high biodiversity and a low per-hectare frequency of commercialised extractivist species, implying a lower potential for high-value extraction.

In the states of southern Brazil (Paraná, Santa Catarina, Rio Grande do Sul), maté is the dominant non-timber product, constituting between 89% and 97% of total non-wood values. In Paraná, it is even more important than wood products. The maté production zones also includes Mato Grosso do Sul. Firewood is a significant extraction product in the rural areas of Southern Brazil, where a more temperate climate provides a potential for energy use from woody biomass.

BOX 3

UNDER-REPORTED EXTRACTIVISM IN THE CENSUS: THE EXTREME CASE OF RIO DE JANEIRO STATE

According to IBGE’s Agricultural Census 1995/96, the value of extraction from native vegetation types (mainly forests) in the state of Rio de Janeiro should only have been a mere R$ 28,057. This compares to the state’s rural population of 599,891 persons (in the 1996 Population Census), a land area of 4,691 million ha, and an approximate forest area of 934 million ha (1990 figure). Additional calculations made available by IBGE on special request show that, out of the state’s 53,680 rural establishments that were included in the census, 53,113 (98.9%) responded to all extraction question with a “goose egg”, i.e. allegedly none of those extracts even firewood from native forests. Of course, this picture is unfeasible, and expresses to a large extent the across-the-board legal prohibition of extraction from the Atlantic forest. However, reported quantities have changed a lot over the last decade, and so has implementation of forest policies. Tanizaki (1997, p. 22) makes a comparison of wood extraction and plantation forestry values for the 1988 to 1993 period, as published by Cide in the Yearly Statistical Survey of Rio de Janeiro State (a source that draws on IBGE data). The newest version Cide (1997) totally abandons data on plant extraction — other than as a title in the index! These figures show a drastic fall in wood and firewood production from both native and plantation forests, implying that production values have not simply been ‘shifted’ from one category to the other. It also indicates that part of the reduction may be ‘real’, so that some wood consumption has been reduced and/or comes increasingly from sources outside of the state. Non-wood products that are *known* to be extracted, in spite of not being registered, include *juçara* palm hearts (*Euterpe edulis*), harvested normally in a destructive manner, bromelia and *xaxim,* a trunk that is cut for ornamental uses (S.Campagnagni, IEF, pers.comm., 6 July 1999).

Figure 1 maps absolute non-wood extraction values for each of the Brazilian states. As can be seen, Pará state (with cabbage palm hearts and fruits) and Maranhão state (with babassu kernel extraction) are dominating, with a respective share of 32.3% and 20.5% of the value generated in the entire country. In the south, maté production also generates relatively high values, so that non-wood values in the three principal producer states combined amount to 19.5%. It is thus remarkable that the top-five of the 27 federal states in Brazil unite 72.3% of non-wood production value. Not only is extractivism highly concentrated in product terms, as was shown in Table 1 above; there is also a high degree of geographic concentration.

Figure 1
Absolute value of non-wood forest extraction
Brazilian federal states, 1995/96

Source: Censo Agropecuário 1995/96 - IBGE.

3.3 - Trends in Extraction Values

Taking one step towards a more dynamic interpretation, one could have a look at how extraction values relate to the value from cultivation of the corresponding products. In theoretical terms, there are some hypotheses regarding the shifting distribution over time between supplies from the two production systems. For instance, the neoclassical theory set out by Homma (1992, 1996) states that many new products will start their incipient commercialisation cycle by an extractivist phase, but with increasing demand over time, the inflexible supply, relatively high extraction costs and resource exhaustion jointly determine the ill fate of extractivism: it inevitably loses out to competitive forms of production, such as product cultivation (plantations) and (natural or synthetic) substitutes. This is a historical product cycle, which already has been completed for many resources of Amazonian origin, such as cocoa, rubber or guaraná (*Paullinia cupana*).

Table 3 does not take an explicit intertemporal approach, but instead a cross-section view on a number of products where simultaneous production systems coexist, i.e. where part of total sectoral supply comes from extractivism and part from either agriculture or plantation forestry. Extraction quantities are compared to quantities produced in cultivation systems, and the products are ranked according to the share of extractivism in total production. As can be seen, cabbage palm hearts and fruits are examples of still almost ‘pure’ extraction products; demand has been rising rapidly in recent times, and cultivation efforts for palm hearts are still incipient (3.9% cultivated products), while slightly more advanced for fruits (23.2%). Note, however, that the cultivator share of all registered producer[24] is larger than the production share (31% and 26%, respectively), meaning that e.g. for palm hearts there are a significant number of small-scale cultivators, while the bulk of produced quantities still comes extraction. This probably also means that, should demand rise even further and/or resources in the wild become increasingly scarce because of destructive harvesting practices (see Box 1), technology and producers would be in place to secure an elastic supply response from cultivation.

Firewood, maté and timber occupy an intermediate position on the scale of extraction *versus* cultivation; the share of cultivated production is in the range of 35% to 70%. For the two wood products, the share of producers that cultivate is much lower, indicating that production is more concentrated in cultivation than in extraction. The opposite is the case for maté tea: 58% of all producers are cultivators. Finally, the last six products have all passed the edge towards a predominance of cultivation, with a share of more than 80%: pupunha palm hearts (*Guilielma gasipaes*), coagulated and latex rubber (*Hevea brasiliensis*), the fruits of cupuaçu (*Theobroma grandiflorum*), and cashew nuts and fruits (*caju; Anarcadium occidentale*). The latter provides a good example of the driving forces for domestication and cultivation, including their unequal geographical

[24] Some producers may both extract and cultivate the same product; they would be counted twice (one extractor, one cultivator) in the present calculus.

Table 3

Comparing the origin of plant products: extractivism versus plantation

Products	Extractivism respondents	Cultivation respondents[3]	Extracted quantity (tons)	Cultivated quantity (tons)[3]			Cultivated area (ha)	Total quantity (tons)	Share of cultivated production (%)	Share of cultivating producers (%)
				Legal Amazonia[1]	Other states	Total				
Cabbage palm hearts	10.804	4.767	86.080	978	2.483	3.461	1.587	89.541	3,9	31
Cabbage palm fruit	39.689	13.640	151.886	45.990	1	45.991	9.723	197.877	23,2	26
Firewood[4]	1.524.767	119.985	42.560	214	25.239	25.453	n.a.	68.013	37,4	7
Maté tea	38.929	53.208	206.594	8	154.332	154.340	44.786	360.934	42,8	58
Timber[4]	44.960	9.528	11.926	59	25.319	25.378	n.a.	37.304	68,0	17
Pupunha	2.107	6.834	279	1.106	192	1.298	602	1.577	82,3	76
Hevea coagulated	7.585	5.080	8.405	14.806	36.021	50.827	61.101	59.232	85,8	40
Cupuaçu[2]	4.187	22.698	980	18.360	87	18.447	7.969	19.427	95,0	84
Hevea latex	137	1.203	321	7.144	12.178	19.322	17.839	19.643	98,4	90
Cashew nut	2.570	195.444	572	5.892	150.224	156.116	492.881	156.688	99,6	99
Cashew fruit[2]	2.054	123.383	5	74	1.607	1.680	145.340	1.685	99,7	98

Source: IBGE; Censo Agropecuário 1995/96, v. 1 "Brasil", and unpublished material made available by IBGE.
Notes: [1]Legal Amazonia comprises Brazil´s North Region, Mato Grosso state and the majority of Maranhão state (fully included in the figures here).
[2]Number of fruits (thousands).
[3]Data for cultivation are from "perennial crops" for non-wood and from "silviculture" for wood products.
[4]Thousands of m^3.

distribution (see Box 4). For all the six products, cultivation shares are larger in production than for producers, meaning that the average production scale in cultivation is larger than in extraction: economies of scale can normally be better exploited in specialised, cultivated systems. For instance, a predominant share of coagulated rubber is produced on large plantations, whereas the share of extractive producers is still as high as 60%.

It has often been pointed out that, Amazonian extraction products are 'exported' to the south for cultivation, to areas closer to large markets, with a more flexible labour supply, with less disease problems, etc. — again, cocoa and guaraná are examples in this respect [see Homma (1996)]. Columns 4 to 6 thus provide additional information on the geographical distribution of production from cultivated areas. Some products are not of Amazonian origin (maté, cashew), others are of mixed sources (firewood, timber). For the rest of products, some confirm the hypothesis of geographical transfer, with a predominant share of cultivation outside of the Legal Amazon (rubber, cabbage palm hearts), while for others plantation has hitherto mainly remained inside the region (cabbage palm fruits, pupunha, cupuaçu).

BOX 4

UNEVEN TRANSITION FROM EXTRACTION TO CULTIVATION: THE CASE OF CASHEW

Since the mid-1970s, Brazil has been progressing steadily as an exporter of cashew nuts. The country now holds about one third of the world market, second to the largest producer, India, and 75% of its exports go to the USA. 90% of all nut production is for export, whereas cashew pulp (for drinks) has remained a secondary, under-utilised and home market-oriented product, mainly because the required conservation additives in the processing of the extremely perishable pulp exceed world market norms [see Figueiras et alii (1997)]. The perennial cashew tree grows best in the coastal hot climate, and is widely distributed in the original area of the Atlantic forest of north-eastern Brazil. Until the 1950s, cashew was a purely extractive product, and cultivation occurred only on an experimental basis. However, with the upswing of the external market in the mid-1970s, the supply from extractivist production proved increasingly insufficient, unstable and too heterogeneous to satisfy growing external demand. Fiscal incentives for cultivation were provided, and the Brazilian Enterprise for Agricultural Research (Embrapa) undertook significant R&D efforts to boost cashew production. As a main result, a new early- and high-yielding cashew variety was developed: a smaller tree with smaller nuts, but with a more than five times higher per-hectare productivity than the common cashew tree [Oliveira et alii (1998), cited in Vasconcelos (1998, p. 12)]. Although in principle, this was a land-saving technological progress, cultivated areas expanded to more than 700,000 ha. Extraction values initially benefited from the export boom, rising to an all-times high of R$ 32.6 million in 1985 (fixed 1997-prices), but during the following years it collapsed under the competition of high-yield plantations. The combined value of extracted nuts and fruits was only R$ 495,000 in the 1995/96 census). As shown in Table 3, cultivated areas now provide 99.6% of cashew nut and 99.7% of pulp quantities. Hence, cashew is a typical case of a product that conforms with the stage-wise adjustment path sketched by Homma (1993): moderate production from extraction — rising demand — insufficient supply — reinforced domestication — irreversible decline of extraction. However, in geographical terms, this trend has been uneven: in the "specialised" states of Ceará, Piauí, Rio Grande do Norte and Paraíba, extraction has declined sharply, but in minor production areas (Pará, Bahia, Pernambuco, Sergipe, Alagoas), it has maintained or even increased its absolute levels. In Alagoas, cashew remains the most important non-timber extraction product.

In the previous section, changes in extraction values from 1980 to 1995/96 have already been noted, at the level of large categories of product sub-groups. Table 4 provides further information, at the individual product level, about the changing US$ values of extraction from 1955 onwards, using both information from previous versions of the Agricultural Census and from the IBGE Statistical Yearbook. Calculated in current US$, non-timber extraction values augment gradually, in particular between 1975 and 1980 where the current US$ value of the eight main products more than doubles. However, from 1985 to 1995/96, a significant decline occurs, in particular for rubber, Brazil nuts, piassava and carnauba.[25] The figures for 1990 are from the PEVS and are inflated by the inclusion of plantation forestry products, e.g. for maté production.

Table 4 is supplemented by the two graphs in Appendix 2, showing the long-run trends in extracted quantities for the same eight products, back to 1920 when the first economic census with information on agricultural production and extraction was carried out. The graphs show that a number of products (rubber, piassava, Brazil nuts, babassu, cabbage palm hearts) experienced a marked growth in consumption for most of the period, in particular between WWII and 1985, but likewise an abrupt decline from 1985 to 1995/96. Only three products deviate from this trend. Maté experiences a marked decline from 1920 to 1945, but a sustained revival after 1955. Cabbage palm fruits as a relatively new product, has experienced a rapid growth since the early 1970s. Finally, the extraction quantities of carnauba exhibit no clear long-run trend since 1920, but marked fluctuations, e.g. with a crisis from 1956 to 1985.

Why have extraction values fallen so sharply from 1985 to 1995/96? One explanation relates equally to all tradable agricultural commodities: the “loss of competitiveness” due to real exchange rate appreciation (“push”); this combines with the boom in urban activities that drew labour out of the rural areas (“pull”). A clear example is Brazil nuts: due to the appreciation of the Brazilian *real*, Bolivian producers have markedly increased their market share, undermining Brazilian extractive reserves (see Box 5). Another effect would link to the hypothesis of “extractivism inferiority”, with sustained, long-run processes of agricultural modernisation and opening up of the economy during the period; the aforementioned case of cashew is an example of such a modernisation trend.

[25] For carnauba wax, this is a “statistical artifact”, in the sense that production has been diversified to other sub-products, such powder and oil. Total carnauba production in 1995/96 is US$ 12.5 million.

Table 4

Extractivism production value growth in Brazil since 1955

(In US$)

Years / currency	Extracted value							
	1955[2] US$	1965[2] US$	1970[1] US$	1975[1] US$	1980[2] US$	1985[3] US$	1990[2] US$	1995[1] US$
Babassu	12.839.289	23.754.445	20.523.294	32.961.014	47.906.183	40.563.277	30.111.716	38.372.301
Rubber	18.098.568	18.489.986	16.744.471	24.912.062	73.852.371	78.087.627	19.986.261	6.909.760
Carnauba wax	n.a.	6.636.432	3.327.529	7.965.935	4.475.631	6.273.611	12.299.941	2.648.493
Maté tea	n.a.	10.651.414	4.544.471	6.974.262	41.118.684	24.918.384	92.110.484	34.875.137
Brazil nut	n.a.	5.658.394	4.077.882	8.401.337	13.268.779	19.378.986	7.224.062	5.688.986
Cabbage palm hearts	n.a.	n.a.	348.941	4.891.496	14.688.728	5.406.838	16.327.742	13.136.006
Piassava	n.a.	3.606.072	3.424.706	6.402.851	9.562.406	20.362.390	69.270.337	13.660.332
Cabbage palm fruits	n.a.	n.a.	n.a.	3.293.591	9.772.599	28.554.855	45.831.745	34.815.441
Total selected products	*n.a.*	*68.796.744*	*52.991.294*	*95.802.549*	*214.645.381*	*223.545.968*	*293.162.287*	*150.106.457*

Notes: [1] *Source: Agricultural Census, different years.*
[2] *Source: Statistical Yearbook, different years.*
[3] *Source: Rubber, babassu, maté and Brazil nuts from Agricultural Census; others from Statistical Yearbook.*

BOX 5

GLOBALISED RAINFOREST PRODUCTS: THE CASE OF BRAZIL NUTS

The Brazil nut is a rainforest product *par excellence*: the tree is considered a "keystone species" in the primary *terra firme* forest where it grows, but equally depends on the forest for survival. Contrary to the palms mentioned above, it is highly vulnerable to fire Homma et alii (1996, p. 522) and depends heavily on agoutis ("*cutia*", *Dasyprocta* spp.) for seed dispersal Shanley et alii (1998, p. 25). It grows at a low density of 0.1-2.5 trees per ha [see FAO (1986, p. 53)]; average is about one tree per ha. The tree is dispersed on about 20 million ha of the Amazon, but harvesting occurs only from the most accessible 2-3 million ha of forest [see Clay (1997*a*)]. Some cultivation techniques have been developed, but practically all production today occurs from natural stands, mainly for economic reasons: from planting to harvesting, there is a lag of minimum six years, but significant quantities are only obtained after twelve to sixteen years [see Müller et alii (1995, p. 50-53)]. The exclusive supply from extractivism entails some problems: the nuts harvested tend to be heterogeneous in size and quality, and year-to-year fluctuations in tree production are large. Due to its socio-environmental importance, felling of Brazil nut trees is illegal in Brazil, but deforestation in areas such as Southern Pará has actually reduced their numbers. One reason is that, due to the low density in the standing forest, per-hectare profitability is extremely low: Homma et alii (1996, p. 529) find an average net return of R$ 352 per 50 ha plot, which was about US$7 per ha in 1995. Large areas needed for harvesting also imply a large labour input into collection and transportation. The extensive commercial chain provides a perfect setting for the "middlemen squeeze": an abundant forest resource with many collectors and an oligopoly of intermediaries, large transport distances, significant post-harvest losses and a heterogeneous output. Clay (1997, p. 270) reports a forest price of just US$ 0.03/lb, rising to US$ 0.12/lb at the intermediary level, US$ 0.70/lb for transport & processing, a price of US$ 0.85/lb FOB Brazil, a US wholesale price of about US$ 2.00/lb, and a US consumer price of around US$ 10.00/lb — i.e. a "value added" of more than three hundred times the forest price! This has encouraged efforts of vertical integration and of more direct marketing, even by virtual markets on the Internet (see e.g. Friends of the Earth 1999). Global demand for Brazil nuts is rather elastic *vis-à-vis* changes in the price of other edible nuts, which provides a pessimistic outlook if large-scale cultivation makes these competitors cheaper (see e.g. Box 4 on cashew). There is also a fierce competition between the main producer countries, Brazil, Bolivia and Peru. The marked real appreciation of the Brazilian *real.* In turn, Brazilian supplies have gradually receded, from a peak of 51,195 tons in 1990 to 26,505 t in 1993 [Homma et alii (1996, p. 521)] and 19,301 t in 1995/96 (see Table 1). This has further eroded the economic basis of Brazilian extractive reserves, which were already hit by the sharp decline in rubber subsidies [Assies (1997)].

4 - PLANT EXTRACTION IN THE AMAZON

4.1 - Mapping Extractive Value Densities

This fourth section will provide a more detailed analysis of extraction values in one particular region, the area of the Legal Amazon. There is both a substantive and a pragmatic reason for choosing the Amazon for this exercise. As to the former, considerable interest has been developed on extraction in this specific region (see reference in section 1). The pragmatic reason is the existence of a comprehensive Amazon data base in IPEA (mainly designed for the institution's analyses of Amazonian deforestation), access to which was kindly made available to me.[26] This sub-section section thus provides a more thorough spatial description of wood and non-wood values, at the municipal level. In prolongation, a cross-section analysis of inter-municipal differences in the per-hectare extraction values will seek to shed light on which factors determine the degree of wealth generated by extraction. This part of the paper may thus be seen as a complement to previous municipal cross-section analyses at IPEA.[27]

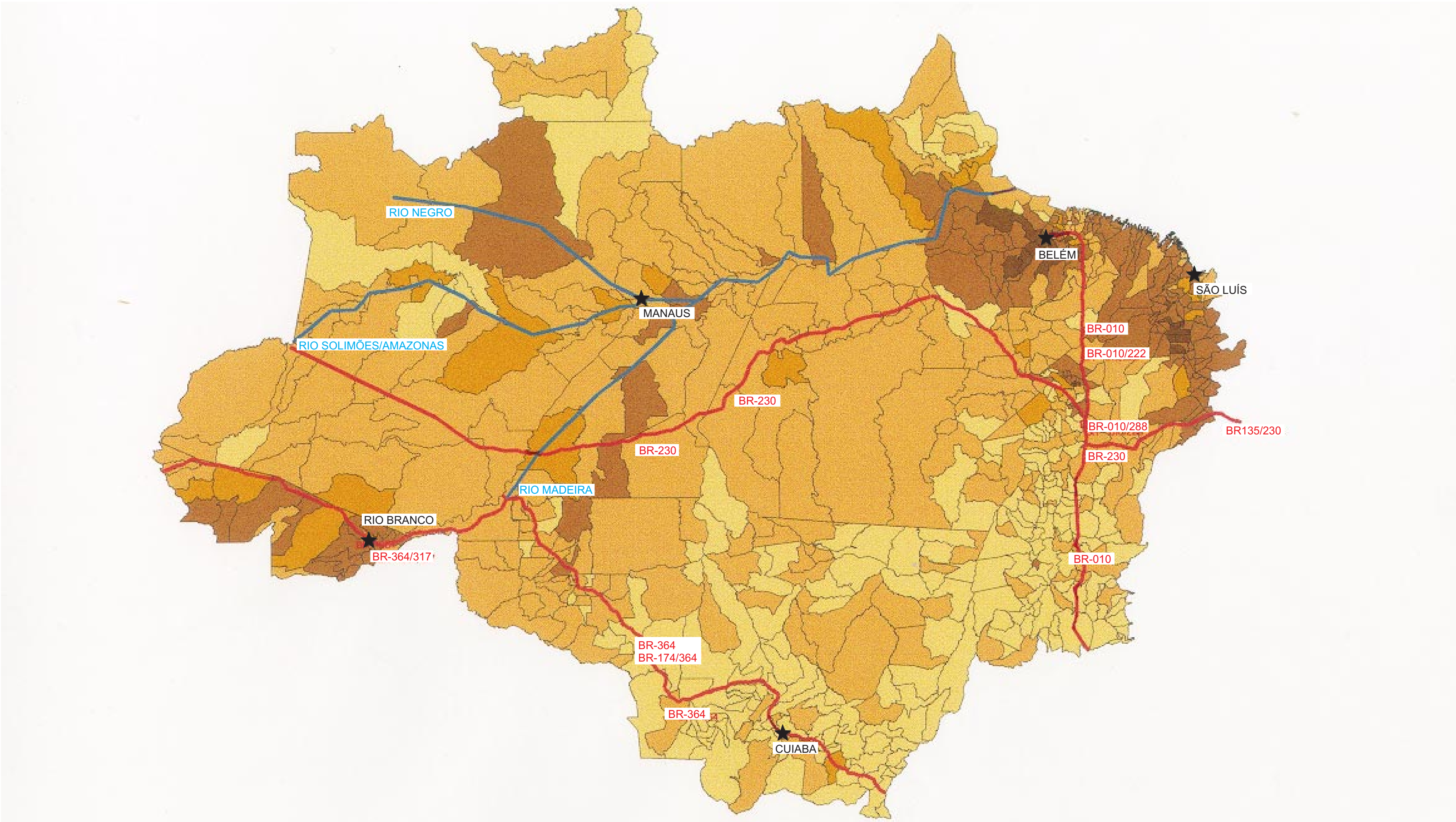
Figure 2 shows the value of non-wood products in each municipality within the area of the Legal Amazon, i.e. the states of Brazil's North region (the federal states of Amazonas, Roraima, Rondônia, Acre, Amapá, Tocantins), plus Mato Grosso and the majority of Maranhão state. For each municipality, the registered value of non-wood extraction of all agricultural establishments was divided by the municipality's total land area. The map thus expresses differences in the land density of value generation.[28] Some of the main roads, rivers and cities have been sketched to allow for easier orientation.

Before turning to the map interpretation, it may be useful to provide some summary characteristics on extraction in the Legal Amazon area. Total extraction value is R$ 373.7 million, of which R$ 118.2 million (31.6%) is non-wood and R$ 255.5 million (68.4%) wood values. Compared to extraction in total Brazil, 33.9% of wood and 62.3% of non-wood extraction values come from the Legal Amazon. This means that non-wood products have a larger relative importance in the Amazon; babassu and cabbage palm fruits are the most important ones. The first impression from Figure 2 is, once again, one of extreme economic concentration. In some municipalities, extraction values are zero, for instance in areas where deforestation has progressed heavily: south-eastern Pará, Tocantins, parts of Mato Grosso, and in general some other areas near the main roads (BR 010, BR 174/364). However, some of the municipalities registered with zero extraction also cast inevitable doubts about the quality of the data collection process (see discussion in section 2).[29] Two more light-coloured categories represent areas with minor extraction activity (ranges R$ 0-0.8/ha and R$ 0.8-0.15/ha), which embrace most of the remaining Amazonian territory.

In economic terms, significant value generation occurs only in the two core categories, marked by the darkest areas in Figure 2 (0.15-10 R$/ha; more than 10 R$/ha). High-value areas can even be labelled by products. In Pará state (eastern Amazonia), in the vicinity of the large capital Belém, one finds what may be called the "assai belt" (or the "fruit belt"). These areas are dominated by the

[26] The "Economic and Social Data for Municipalities in the Tropical Amazon" — [see Desmat (1999) for a general description].
[27] See, for instance, Reis and Margulis (1991), Reis and Gúzman (1994) and Andersen and Reis (1997).
[28] Note that division is made by total land area, not the natural forest area of the municipality. The figures can thus not be interpreted as per-hectare forest extraction values.
[29] It is simply impossible that certain municipalities in the heart of heavily forested states such as Amazonas, Roraima or Amapá should have a blank value, implying that not even a single family extracts *anything* (different from wood) — say, medicinal plants, fruits or fibres — from the forest.

Figure
alue of non-wood forest extraction per unicipal area
egal A azonia, 1995/96



CLASSES (R$/ha): 0; 0 – – | 0.08; 0.08 – – | 0.15; 0.15 – – | 10; More than 10

Source: Censo Agropecuário 1995/96 - IBGE.
Malha Municipal Digital do Brasil 1994 (IBGE/DGC/DECAR).

extraction of cabbage palm fruits and palm hearts from riverside areas, in some cases supplemented by other fruits, such as bacuri (*Platonia insignis* Mart.) and cupuaçu. Two factors seem to make the area "special": the previously intervened Amazon estuary environment that is particularly favourable to dense stands of cabbage palms, and the closeness of the area to a large market for açaí fruits (processing and consumption) in Belém.[30]

The second high-value area is the "babassu belt" in Maranhão State (also Eastern Amazonia). As shown in Table 1, babassu oil is the economically most important non-wood extractive product in Brazil. The "comparative advantages" of the geographical area seem to be of the natural type, with soil and climatic conditions, combined with the impact of previous land degradation: babassu favours degraded landscapes because it tends to be a dominant element in pioneer vegetation regrowth after burning.

It is thus worth noticing that the ecological characteristics of both the identified high-value extraction areas, the assai and babassu belts, are highly distinct from the biologically diverse, primary, closed *terra firme* rainforest. A large part of theses production belts tends to be previously intervened areas characterised by a large frequency of dominant, commercialised palms, sometimes occurring in almost monotonous stands ("quasi-plantations"). As shown in section 3, other economically important Brazilian non-wood extraction products from outside the Amazon (piassava, carnauba) share an origin from areas with similar ecological characteristics.

Appendix 1 allows for a closer look at the 18 non-timber high-value municipalities with a per-hectare extraction superior to R$ 10. Of these "special" municipalities, seven are in the state of Pará (assai belt), seven in Maranhão and two in Tocantins (both babassu belt). With a combined extraction value of R$ 47.5 million, they unite no less than 42.2% of all non-wood extraction in the Legal Amazon, and one fourth of the value in all of Brazil. Their weighted-average value-density (R$ 16/ha) is 73 times higher than that of all the Amazon (R$ 0.22/ha). The table compares some of the main soil and vegetation characteristics of those municipalities with that of the respective federal states and of the Amazon region. For instance, some high-fertility soils exist in the babassu region, implying that the share of those municipalities with 25.4% is much higher than in the states of Pará (2.2%), Tocantins (4.2%), Maranhão (12%) and the Amazon (6.5%). Other special characteristics of the municipalities are: a lower share of low-fertility soils, the lack of open rainforest vegetation, a higher share of savannah and, in particular, an extremely high share of pioneer vegetation. These deviations from the regional norm will be more fully explored in the regression analysis below.

[30] Figure 2 clearly denotes that the highest values (the darkest areas) are found along the rivers very close to Belém.

In addition to the areas of highest value, there are a number of secondary areas, with per-hectare extraction values in the range of 0.15-10 R$/ha. First, this refers to the large peripheral zones of the babassu and assai belts. Secondly, it concerns a number of more isolated areas: in the state of Acre and Rondônia (dominated by rubber), and in Amazonas state near the city of Manaus (where piassava is an important product).

Figure 3 shows the corresponding per-hectare value density for wood products, again at the municipal level. A first observation is that very few municipalities record zero values, contrary to what was the case for non-wood. This is because firewood extraction is a common feature in most rural areas, probably generating low but quite uniform per-hectare value levels (0-0.5 R$/ha). What is beyond this level is mainly attributable to logging, and in some cases to charcoalii Whereas an ‘arc of deforestation’ has been observed in the Amazon, from the state of Pará to Mato Grosso, Rondônia and Acre, a corresponding “arc of logging” has been noticed just in front of that area, where loggers indirectly prepare the ground and provide access for forest burning and conversion. Although the IBGE figures probably underestimate the extent of logging, it is possible to see the vague contours of a “logging arc” in Figure 3: from the traditional centre in Pará state[31] to the more recent production areas in Mato Grosso and, to a lesser extent, Rondônia. A second area of significant wood production is Maranhão state, where babassu kernel extraction is combined with charcoal-making from the shells of opened nuts,[32] but also containing the large charcoal production of the Grande Carajás area.

In Figure 4, wood and non-wood values have been summed up, and are combined in one single map. Wood products make up two thirds of the total value, so their sheer size should make them the dominant variable. However, non-wood extraction values are much more unequally distributed, so that a number of relatively small, high-value municipalities are highly influential (see above): the *unweighted* average of non-wood extraction in all 628 municipalities is R$ 0.97; the median is only R$ 0.006. Curiously, this non-wood average is almost the same as for wood products: R$ 1.03; here the median is R$ 0.29.[33] This means that, specifically in terms of the high-value municipalities in Figure 4, non-wood values are just as well represented as wood values.

[31] According to the IBGE figures, log extraction in Pará generates a gross income of R$ 96.3 million, which corresponds to 47.4% of the national value (see Tables 1 and 2).
[32] A closer inspection of eight municipalities with high-value babassu extraction (Appendix 1) shows that, in each of the sites, charcoal was the second most important extraction product after babassu.
[33] This paradox is even more pronounced when calculated at the level of Minimum Comparable Areas of 1970 (MCAs), i.e. municipal units that are partially aggregated in order to make them comparable over time, in spite of the sub-division of municipalities (see regression analysis below). Here, the unweighted average of non-wood is 1.85 R$/ha versus 1.49 R$/ha for wood. This means that some large MCAs that produce much wood enter with little weight into the averages, compared to small MCAs with high non-wood intensity.

Figure
alue of wood extraction per unicipal area
egal A azonia, 1995/96

RIO NEGRO
BELÉM
SÃO LUÍS
MANAUS
RIO SOLIMÕES/AMAZONAS
BR-010
BR-010/222
BR-230
BR-010/288
BR135/230
BR-230
BR-230
RIO MADEIRA
RIO BRANCO
BR-364/317
BR-010
BR-364
BR-174/364
BR-364
CUIABA

CLASSES (R$/ha)	0	0 – – | 0.5	0.5 – – | 3	3 – – | 10	More than 10

Source: Censo Agropecuário 1995/96 - IBGE.
Malha Municipal Digital do Brasil 1994 (IBGE/DGC/DECAR).

The map thus underscores the aforementioned centres of extractivist activity: the entire northern part of Pará State (timber and assai belt), the babassu belt in Maranhão and parts of Tocantins (kernels and charcoal), plus high-value "islands" in Mato Grosso, Acre and Amazonas states. It also seems to document that, like for other economic activities, closeness to the larger cities (Belém, Manaus, São Luís, Rio Branco), rivers (the Amazonas) and roads (BR-010, BR-364, part of BR 230) increases the options for value generation, as market access is facilitated. In turn, some of the large, isolated municipalities in the central and northern Amazon generate little extraction value, if credit is to be given to the IBGE figures.

One potential point of criticism *vis-à-vis* the usefulness of Figures 2-4 refers to the general relevance of per-hectare values. The typical Amazon frontier may be characterised as a land-abundant environment [see Schneider (1995)]. Hence, land would not be any serious constraint to extractive production, and economic agents would be inclined to base their land-use decisions on comparative per-capital and per-labour returns to the establishment's assets [see Young and Fausto (1997)]. This critique would also apply to the econometric analysis in the following section. Lacking appropriate data on the activity distribution of financial capital, Figure 5 at least partially meets this concern, by calculating the value of non-wood extraction per number of establishment, which may serve as a proxy for labour availability in the respective municipality. Roughly speaking, values are being related to population rather than to land size.[34]

Figure 5 shows that the geographic distribution of non-wood extraction value per establishment is even more skewed than the corresponding per-hectare values. Municipalities with an average yearly value of more than R$ 500 per establishment are limited to some high value units in northern Pará and Amazonas.

An interesting observation is that some thinly populated areas in the northern and western Amazon, which were described as low-value per hectare in Figure 2, come out with intermediate values per establishment (R$ 30-500). At the same time, more populous areas in Maranhão and Acre states, which had relatively high per-hectare values, score only intermediate values in Figure 5. The values per establishment thus add another dimension to the description of extraction values.

[34] This generalisation ignores, first, inter-municipality differences in average household size; second, the amount of hired labour and, third, differences in the geographical distribution of non-household establishments (companies and other commercial enterprises).

fig 5

4.2 - Explaining Spatial Differences in Extraction Values

This section will try to elucidate the 1995/96 inter-municipal differences in extraction value that have been observed for the Legal Amazon in the previous section. In prolongation of the visual analysis of maps, this econometric cross-section exercise will hopefully shed further light on the determinants of extraction value. What type of economic and biophysical scenario is favourable to extractivism and, *vice versa*, what factors tend to act as obstacles to the generation of high extraction values? First, a regression model with an economic rationale will be applied, testing *a priori* hypotheses regarding extractivism. As a second step, the economic model will be combined with different biophysical variables, using stepwise selection procedures that maximise the explanatory power of the regression model, for a pre-determined significance level of the selected variables.

The dependent variable of the analysis will be the extraction value density per hectare of municipal area, i.e. the study unit is the spatial distribution of wood, non-wood and total extraction, as depicted in Figures 2, 3 and 4, respectively. Correspondingly, the absolute value of the independent variables will be 'normalised' by dividing with municipal land area: all variables are expressed either in land densities or in percentages. Normalisation of variables is desirable because municipalities differ markedly in size, so that the direct use of absolute variables in the regression model creates a spurious correlation.[35] Normalisation alternatives to land densities exist; for instance, the World Bank uses both land size, population size and national income size as denominators in cross-country comparisons [see World Bank (1998)]. In theoretical terms, pros and cons can be mentioned for the use of different densities, but the final choice of land area as denominator was empirically determined.[36]

The units of our analysis are the 256 Minimum Comparable Areas (MCAs), a concept that is applied because explanatory variables from different years had to be used (e.g. road extension in 1993, credit provided in 1985). For a dynamic region like the Amazon, new municipalities are created relatively frequent, which makes it necessary to adjust the unit of analysis backwards. The results of the economic model are shown in Table 5. The first column refers to the parameter values and significance levels for non-wood, the second to wood and the third to

[35] In addition to spurious correlation, it may also introduce problems of multicollinearity between the explanatory variables, as was detected in some of the model runs that were tried out. An alternative to the application of densities may be a logarithmic regression model, but this is not helpful in the present case: the large number of municipalities with zero extraction values would reduce the sample significantly.

[36] As an alternative, division of all variables by the number of establishment was tried, but the R^2 of our model proved to be extremely low and most variables came out insignificant. This is probably because the distribution of extraction values per establishment is even more skewed than the one per hectare, a pattern which it thus results even more difficult to explain econometrically (see Figure 5 above).

Table 5

Economic explanations of spatial variations in extraction values

Regression results, Legal Amazon, minimum comparable areas, 1995

Variable		Non-wood value[1]		Wood value[1]		All extractivism value[1]	
Constant							
	Coefficient	- 0.40		0.12		- 0.28	
	T-value	- 0.61		0.34		- 0.36	
1. Number of establishments` (n./ha)[1]							
	Coefficient	126.20		53.00		179.21	
	T-value	5.36	***	4.29	***	6.28	***
2. Establishments natural forest area (%)[1]							
	Coefficient	7.93		9.98		17.92	
	T-value	2.06	**	4.95	***	3.85	***
3. High fertility soils (%)[1]							
	Coefficient	0.04		0.004		0.04	
	T-value	2.91	***	0.59		2.65	***
4. Wage labour share (%)							
	Coefficient	- 4.11		- 1.26		- 5.37	
	T-value	- 1.69	*	- 0.92		- 1.71	*
5. Public credit share $_{t-1}$ (%)[2]							
	Coefficient	- 1.52		- 1.45		- 2.97	
	T-value	- 0.71		- 1.30		- 1.15	
6. Roads (km/ha)[1, 3]							
	Coefficient	8.95		- 0.10		8.85	
	T-value	0.54		- 0.01		0.45	
7. Navigable rivers (km/ha)[1]							
	Coefficient	80.81		22.05		102.86	
	T-value	3.41	***	1.77	*	3.58	***
8. Establishments` occupied lands (%)[1]							
	Coefficient	- 0.25		26.70		26.45	
	T-value	- 0.02		3.24	***	1.39	
9. Establishments` leased lands (%)[1]							
	Coefficient	6.24		- 73.98		- 67.74	
	T-value	0.11		- 2.52	**	- 1.00	
10. Medium size of establishments (ha)							
	Coefficient	0.0004		- 0.001		- 0.0006	
	T-value	0.38		- 1.61		- 0.38	
Number of observations		256		256		256	
R^2		0.2456		0.2716		0.3303	
Adjusted R^2		0.2150		0.2420		0.3030	
F – value		8.010		9.171		12.131	

Notes:
[1]Values divided by the municipalities` total area.
[2] The share of financing from Banco do Brasil and from the government in gross monetary agricultural income, 1985.
[3] Length of federal and state roads, both paved and non-paved, in 1993.
* Parameter T - value significant at the 10% level.
** Parameter T - value significant at the 5% level.
*** Parameter T - value significant at the 1% level.

the combined extraction values.[37] Three different types of independent variables are distinguished, as described in the following.

The first three variables approximate typical production function elements. As mentioned in last section, the number of agricultural establishments per hectare can serve as a crude approximation of the density of labour inputs into production. This variable results highly significant (at a 1% significance level) in all regressions: the higher the density of establishments, the higher all types of extraction densities. Second, the density of natural forests (establishments' natural forest area divided by total area) must also be expected to be highly correlated with extraction values,[38] as it represents the main native ecosystem from which extraction by definition occurs.[39] Also this variable is highly significant, although slightly more so for wood than for non-wood extraction: the higher forest density, the higher extraction densities.[40] Third, one may expect that, for an activity based on vegetation growth, not only matters the size of the area but also the quality of soils. The percentage of high-fertility soils proves to be significant, but only for non-wood and aggregate extraction, not for wood products. The question of different soil and vegetation types will be more fully explored below.[41]

The second group of variables refers to market and infrastructure development. Two opposed theoretical expectations may apply here. On the one hand, like for any other economic activity, better infrastructure and market mediation would *ceteris paribus* tend to increase the options of value generation. Contrary to this view, one may conjecture that when markets and infrastructure are well-developed, extractivism as an alleged 'inferior' production mode will decline, in favour of competing economic activities, i.e. extractivism will tend to survive only in areas of economic backwardness.

The average wage-labour cost share may be seen as a proxy for the development of labour markets: the lower this share, the more the emphasis on household establishments characterised by self-employment. The variable is generally estimated with a negative sign, significant at the 10% level for two of the value

[37] Note that, as the third row variable is a sum of the first two, its coefficient must also be equal to the sum of the coefficients estimated for wood and non-wood, respectively.

[38] Note that this figure does not refer to the *total forest area* of a municipality, but the forest-covered area within the agricultural establishment, because this is the unit of analysis of the Agricultural Census. Those state forest lands that are neither owned or occupied by agricultural establishments are thus not included here.

[39] However, extraction also occurs from non-forest native ecosystems, such as *cerrado* (savanna) and *caatinga* (steppe), and various transition systems. See Table 6 for a more detailed analysis.

[40] Deforestation was attempted to be included as a dynamic element: logging is often said to operate in conjunction with deforestation, whereas non-wood extraction often is said to be incompatible with forest conversion. None of these effects were confirmed in the regressions.

[41] An economic approach to capture qualitative factors regarding land use is to include land prices in the model. Land prices were not inquired in the new census, so 1985 figures were used, but the variable proved to be insignificant in all the regressions.

categories. Similarly, the share of public credits in agricultural income[42] may be taken as an indicator for the importance of credit markets for value generation. Again, the variable is estimated with a negative sign in all three regressions, but not at a significant level. In other words, high-value extractivism tends to occur more in areas with under-developed labour and credit markets, though for credits not in a significant manner. An interesting third variable in this segment is the municipal density of roads (km/ha of both federal and state roads, both paved and non-paved); often, the vital importance of road infrastructure for the economic viability of agricultural production in rural areas is recognised. Somewhat surprisingly, road density is insignificant, and is estimated with shifting signs.[43]

A second infrastructure variable is river density; navigable rivers may be important transport arteries in many forested areas where little road construction has occurred. The river variable is also estimated with a positive, significant sign (for non-wood and aggregate extraction, even at the 1% level). Rivers would thus appear to be more important means of transport in benefit of extraction activities. However, as a note of caution, the river density correlation may reflect not only the importance of rivers for transport, but also to a certain extent the type of soils and vegetation that predominates riverside environments (see below).[44] On aggregate, the coefficients estimated in this second part of Table 5 thus lend moderate support to the "inferiority hypothesis": extraction per-hectare values tend to be slightly higher in areas with limited input market development (labour, credits) and with natural, river-based transport systems, rather than roads.

The third group of variables concerns the institutional framework, in particular questions of land tenure. Does the predominance of certain types of land tenure and land owners favour or disfavour extractivism? In Table 5, both the average share of municipal establishments' occupied lands, the share of leased lands, and the medium size of the establishments were investigated. Only two of the parameters proved to be significant, both for wood extraction, which tends to occur less on leased lands and more on occupied lands. There is also a slight, insignificant trend that wood extraction occurs more on the establishments of small size. This picture makes a lot of sense for timber harvesting, the dominant factor of geographical value variation for wood products, which relatively often occurs in areas of recent occupation where land titles have not yet been granted. On the other hand, leasing arrangements are more related to agricultural and pastoral activities, less so for native vegetation types. For non-wood extraction, none of the tenure variables has any significant influence.

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[42] Only a lagged variable was available, from the previous census (1985), using as an indicator the share of financing from the publicly owned *Banco do Brasil* in gross monetary agricultural income.

[43] It was also tried to estimate separate values for paved and non-paved roads, but that did not change the insignificance of the variables involved.

[44] The size of output markets was another factor which it was tried to capture through urban and rural population density, and through urban and total income density, but without good empirical results for any of the four variables. In spatial terms, it may be more relevant to look at the municipality's distance to larger cities (Belém, Manaus, São Luís, etc.); in the map section, this appeared to be a significant factor.

In summary, the ten explanatory variables included in the economic model, reflecting production function, infrastructure and land tenure conditions, are able to explain one fourth of the spatial variation in non-wood (R^2 = 24.6%) and one third of the variation in total extraction values (R^2 = 33%). These values may be considered intermediate for this type of cross-section analysis.[45] Notably, the production function variables proved to be the most significant, complemented by various additional factors. Both soil fertility and natural forest density proved to be highly significant. Considering the variable ecological requirements for the large array of products concerned, it was thus decided to attempt an explanation of the same dependent variables by a more detailed biophysical analysis of disaggregated soil and vegetation types, the results of which are reproduced in Table 6.

The approach taken here was somewhat different from the economic model, in the sense that no theoretically founded *a priori* expectations existed on which types of soils and vegetation would be particularly favourable to extractivism. Consequently, instead of starting out with a pre-established set of variables, a stepwise regression procedure[46] was used to discriminate between significant and insignificant variables, using a cut-off entry level of 15%.[47] The tested variables included 27 soil classifications and 15 vegetation types, supplemented by the eight remaining variables from the economic model above.[48] The total of 50 variables is too large for a simultaneous computation, so the analysis was divided into two stages.[49] Table 6 thus shows the selection procedure's "end model" for each of the three value categories, showing those among the 50 investigated variables, which are significant at the 15% level.

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[45] Simple control measures (multicollinearity, outliers) indicated no deviations from some of the standard assumptions behind the regression model.

[46] Specifically, the Forward Selection procedure in the statistical software package SAS was applied.

[47] The decisive statistical criterion for entry of a variable is the F-test, testing if the specific independent variable could be excluded from the model with deteriorating significantly the model's ability to explain the variation in the dependent variable. Alternative criteria may be the "adjusted R^2 '(R^2 corrected for the growth in the number of explanatory variables), or 'Mallows C(p)", a measure which relates to the skewness of estimates and the power of prediction of the model — factors which are of little relevance to our case, where we simply seek to identify a set of variables that reasonably explain value variations.

[48] Two of the variables from Table 5, "high fertility soils (%)" and "establishments' natural forest area (%)", were replaced by the more disaggregated soil and vegetation variables. The source of these variables was the SIG-AML project, the results of which are included in IPEA's Desmat data base (see above).

[49] First, the eight economic variables were re-examined together with the 15 vegetation variables. The selected significant variables were then scrutinized together with the remaining 27 soil variables.

Table 6
Biophysical explanations of spatial variations in extractivism values
Regression results (forward selection), Legal Amazon, minimum comparable areas, 1995

Variable		Non-wood value[1]		Wood value[1]		All extractivism value	
Constant							
	Coefficient	- 0.39		- 0.8		0.13	
	F-value	1.01		0.10		0.09	
1. Number of establishments (no./ha)[1]							
	Coefficient	117.71		37.23		180.10	
	F-value	29.65	***	9.84	***	52.15	***
2. High fertility soils with excess humidity (%)[1]							
	Coefficient	0.07		0.02		0.09	
	F-value	15.19	***	5.19	**	23.94	***
3. Medium fertility soils with excess humidity (%)[1]							
	Coefficient	0.20		0.12		0.33	
	F-value	42.52	***	46.98	***	88.16	***
4. Low fertility, latericious soils with excess humidity							
	Coefficient	0.04		-----		0.05	
	F-value	5.94	**			8.92	***
5. Saline soils of restricted use with excess humidity (%)[1]							
	Coefficient	- 0.04		-----		- 0.05	
	F-value	4.86	**			4.75	**
6. Areas with water cover (%)[1]							
	Coefficient	- 0.16		- 0.10		- 0.22	
	F-value	3.77	**	5.19	**	5.66	**
7. Vegetation with pioneer formations (%)[1]							
	Coefficient	0.02		-----		-----	
	F-value	2.57					
8. Establishments` occupied lands (%)[1]							
	Coefficient	-----		29.36		-----	
	F-value			13.24	***		
9. Closed rainforest (%)[1]							
	Coefficient	-----		0.009		-----	
	F-value			5.44	**		

Number of observations	241	241	241
R^2	0.3714	0.3524	0.4879
Mallows C(p)	-2.85	- 3.71	- 3.80
F – value	19.76	21.31	37.33

Notes:

[1]Values divided by the total municipalities` area.
**Parameter significant F- value at the 10% level.*
***Parameter significant F- value at the 5% level.*
****Parameter significant F- value at the 1% level.*
----- Parameter's F - value not significant at the 15% level.

An initial observation is that the only two "surviving" variable from the economic model in Table 5 are the density of agricultural establishments (with a high level of significance for all three value categories), plus the share of occupied lands (specifically for wood extraction).[50] Two soil categories come out with positive coefficients that are significant for all three categories of extraction: high- and medium-fertility soils, both with excess humidity. For non-wood, and for total extraction, the share of low-fertility latericious soils with excess humidity is also a significant explanatory variable, with a positive coefficient. On the other hand, the share of saline, humid soils of restricted use — the less apt soils — is estimated with a negative, significant coefficient. The same applies to a high share of areas covered by water (lakes, swamps, dams, etc.), which, naturally, goes along with lower value generation. Note that the forward selection model, in general, reaches higher R^2 values than the economic model in Table 5, explaining between one third and half of the variation of the dependent variables.

How is this pattern of selected soil and vegetation categories to be interpreted? The positive, significant coefficient for three of the soil classes with excess humidity is probably explained by the high extraction of both fruits (like açaí) and timber from riverside environments (*várzeas, igapós*, estuaries) where soils are seasonally inundated or otherwise subject to a high water exposure.[51] The two types of vegetation that are selected in the computation provide an interesting supplement to this picture: a high share of pioneer formations goes along with high non-wood extraction values[52] (insignificant for wood extraction). On the other hand, a high share of closed rainforest goes hand in hand with high wood values (insignificant for non-wood extraction).

To understand the implications of these results, one should bear in mind the distribution of soil and vegetation types in the entire region. The three soil categories with excess humidity that were estimated with a positive sign occupy together 9% of the area of the Legal Amazon, according to the SIG-AML figures. Correspondingly, pioneer vegetation occupies only 2.5% of the Legal Amazon, whereas closed rainforest covers 43.9% of the area. This provokes thoughts not only on the poor representativity of the high-value areas, but also on the link to biodiversity. It is recognised that, on average, dense *terra firme* dry-land rainforest holds a higher biological diversity and species endemism than both *várzea* and pioneer vegetation types. Unfortunately, the lack of full municipal coverage on

[50] Direct comparison between the two models (Tables 5 and 6) might have been restricted by the fact that, due to lacking data, the number of observations in the latter was only 241, i.e. 15 MCAs less than in the regressions of Table 5. A control regression was run for the economic model, deleting those 15 MCAs where no disaggregated soil/vegetation data was available. The exclusion of the 15 MCAs causes no significant changes in the estimates, confirming that a direct comparison between Table 5 and 6 can legitimately been made.
[51] Note that the navigable river density from Table 5 does not come out significant in the stepwise selection procedure, denoting that its original correlation is probably absorbed by the corresponding soil variables.
[52] The significance level of pioneer vegetation in the 'end model' is 11%, i.e. it is significant at the 15%, but not at the 10% level. However, this changes when the set of independent variables is changed.

biodiversity data made it impossible to include this aspect explicitly in the regression analysis, yet more restricted evidence indicates that there may be a negative correlation between high-value non-wood extraction areas and high indices of biodiversity.[53]

The results, though incomplete in their assessment of biological diversity, thus seem to lend support to those claiming that tropical timber continues to be the most valuable product extracted from the closed, low-fertile but biologically highly diverse *terra firme* rainforest that covers most of the territory of the Amazon. In turn, non-wood extraction at an economically significant scale tends to occur mostly from restricted niches, which indeed are little representative of the Amazon forest as such. The are characterised by a high frequency of commercial species (especially palms), and they often have a history of notable previous anthropogenic modifications. Prominent areas here are different pioneer vegetation types and riverside ecosystems, neither of which are characterised by the same average biological diversity as the *terra firme* rainforest, but which hold a high frequency of commercial species.

5 - CONCLUSION AND DISCUSSION

According to the IBGE data, plant extractivism is a minor productive sector. Even minor is the particular value of non-wood plant extraction products. These products may often be harvested in an ecologically more benign manner than wood, but in the 1995/96 census they only made up R$ 189 million, about one fourth of the total extraction value. Other plant extraction values fall mainly on three wood products: timber, charcoal and firewood. Many individual non-wood products registered increased quantities and values up to the 1985 census, although with marked fluctuations over time, but absolute values have declined during the last decade. In relative terms, decline has been even more pronounced, compared to the expansion of cultivated agricultural production. In 1939, total extraction value of R$ 492 million made up 6.2% of total agricultural production [see IBGE (1950, p. 3)]. In 1995/96, total extraction of R$ 754 million corresponded to only 1.6% of total agricultural production values. A shift from extraction to cultivation has been an integrated feature of long-run structural change in the agricultural sector, supporting those who, in a historical perspective, view extractivism as a transitory, 'inferior' production type.

A critical issue for the interpretation of the presented results is the validity of the IBGE data: are there structural biases in the agricultural census which cause an

[53] Data from the forest inventory of the RADAMBRASIL project area are reproduced in Desmat (1999, p. 10). These include the number of tree species registered in the inventory of 67 municipalities, which could be taken as rough indicators of biodiversity. The pair-wise Pearson correlation coefficient between the number of registered tree species and the absolute non-wood extraction values is negative (but insignificant); the corresponding coefficient between tree species and non-wood extraction density (per ha) is also negative (significant at the 10% level).

undervaluation of extraction in particular, i.e. more than is the case for agricultural production? Indeed, such factors are present:

- the focus, duration, frequency and level of detail of the census interviews do not allow for a full appreciation of minor but multiple uses of forests and other natural ecosystems;

- census coverage is probably more restricted in forest-near agricultural frontier settings;

- illegality of forest extraction causes deliberate omission and understatement in some regions,

- landless producers (who are not proper "agricultural establishments") are excluded, and

- game and other animal resources are not included.

An extremely scrupulous interpretation would thus state that the census is generally more representative of "formal" (legal, commercial) than of 'informal' (illegal and/or subsistence) production. On the other hand, that seems over-cautious, in the light of the actual registration of many auto-consumption uses, from wood (e.g. firewood) to non-wood products (e.g. buriti, assai, ciruella, etc.). For a product like babassu, cross-checking with detailed case studies showed that auto-consumption is well registered in the Census. Hence, a key question is in how many municipalities the value of neglected multiple but minor auto-consumption uses adds up to something which is significant, as a share of total production value. At the aggregate level of Brazil, some under-valuation indeed occurs, with significant errors for several federal states, but the census is still an extremely valuable tool, which contributes vitally to a general overview. This is badly needed, in order to avoid the erroneous extrapolation of highly site-specific case-study evidence.

Another potential critique of the analysis above would refer to the aggregation level of the analysis: using municipal *averages* of extraction values may be too broad to capture the important subgroup of forest-dwelling people for whom extraction is a substantial source of income. This would mean that an important socio-environmental dimension is erratically sacrificed on the altar of macro-sectoral assessment. To meet this concern, additional calculations at the establishment level were requested from IBGE, computing the share of (wood and non-wood) extraction in the total income of each agricultural establishment.[54] This makes it possible to identify the number of the establishments that can be said to actually live off extraction, at different levels of specialisation.

[54] Specifically, IBGE was asked to calculate income from all plant extraction, divided by the value of all on-farm agricultural production (value of plant and animal production, plus of on-farm processing). Eight income share ranges were pre-defined.

Appendix 3 shows some of the results for Brazil's 27 federal states. For all of Brazil, 144,824 establishments (3%) are 'specialised extractivists' i.e. they derive more than 50% of their on-farm income from extraction; for about half of these, extraction's income share is above 75%. This is somewhat more than one would expect from the 1.6% value of extraction in agricultural production. Again, the highly specialised groups are extremely concentrated geographically. The 75%-100% range probably represents mainly timber extraction (Pará and Amapá states) and some babassu/charcoal makers (Tocantins, Maranhão). Apparently, babassu/charcoal is also well represented in the 50%-75% range (Maranhão), together with some fruit producers (Pará) and Brazil nut/rubber extractors in Acre. None of the other federal states registers a share of more than 3% in this income bracket.

As a second group, 6.7% of all establishments in Brazil register what could be called an "important complementary income from extraction", in the range of 15%-50% of their total on-farm income; again the shares are largest for the aforementioned states, plus in the northeast (Ceará, Piauí) and in Amazonas state.

Consequently, about 10% of all Brazilian agricultural establishments derive a significant share of their farm income (more than 15%) from extraction. On the other hand, almost two thirds (63.1%) of the establishments are reported to have no extractive incomes at all. The disaggregated analysis of establishments thus adds a new element to the picture, by revealing a relatively large number of specialised establishments, but in qualitative terms, it does not change the conclusions from above in any significant manner.

Specifically for the Amazon region, the regression analysis in section 4 confirmed that extractivism is highly dependent on labour inputs and, to a certain extent, on river transport. The statistical results lend moderate support to the "inferiority hypothesis", stating that extractivism is more likely to survive in areas with under-developed input markets and poor road infrastructure. In general, biophysical variables proved to provide more powerful explanations of the spatial differences in value generation than the economic model. Extractivism appears to be extremely dependent on specific soil and vegetation types, e.g. riverside and pioneer vegetation areas for non-wood products. In turn, timber and other wood extraction is spatially more diversified, as it occurs both from closed forest areas and from riverside environments.

In spite of the large number of non-wood forest products that are included in the census, non-wood extraction values occur in an extremely concentrated way, more than is the case for wood products: diversity in use does not preclude compression in values. Concentration refers both to products and to geographical areas. 18 high-extraction municipalities, distributed on the "assai belt" (Pará state) and the "babassu belt" (mainly Maranhão, marginally Tocantins state), concentrate an astonishing 25% of total non-timber extraction values in Brazil. Likewise, products from the top-five plants, babassu, maté, cabbage palms (assai), piassava and carnauba generate 78% of all non-timber extraction value. Production of piassava (Bahia state), carnauba (Ceará state) and maté (southern Brazil) occur almost as concentrated geographically as babassu and assai. It is noteworthy that four of the five high-value plants are palm trees, and none of the non-wood products traditionally associated to rainforests, like tapped rubber or Brazil nuts, currently enters the top-five list.

What are the general characteristics of these geographically defined product belts? Most of them are situated in market-near areas, in ecological niches with specific soil and vegetation types. Notably, most are previously intervened or degraded areas that now are covered by pioneer vegetation, as well as *várzeas* and other riverside areas with high humidity. These environments are characterised by dominant commercial species, sometimes up to the point of becoming "quasi-plantations". This feature is inherent to the succession dynamics of natural regrowth, but it is often combined with management practices to deliberately eliminate competitive vegetation, e.g. by the repetitive use of fire. The high site-specific concentration of commercial species reduces harvesting and management costs, and thus markedly increases the economic viability of extractivism.

However, it is equally clear that the characteristics of these areas are little representative of Brazilian tropical forest biomes in a broader sense, neither of the Atlantic nor the Amazon forests. Most of all, this observation refers to the ecological setting: biological diversity tends to be much higher in *terra firme* dry-land, closed forests, which covers almost half of the Amazon's land area. The fact that large household incomes are derived from a single-species (or handful of products') harvest in market-near *várzeas* or pioneer vegetation areas says just about nothing about the income-generation options from highly diverse tropical forests. Even worse, if such results are extrapolated carelessly by over-enthusiastic forest conservationists, they may raise highly unrealistic expectations about the profitability of non-wood forest-product harvesting — a boomerang which is bound to hit back once disappointing field results begin to speak for themselves.

High biodiversity also means a lower frequency of single commercial species per land unit, which drives up harvesting, transport and management costs — and increases the temptation of over-harvesting [see Peters (1994, p. 6)]. In such a scenario, only the most valuable products (such as precious timber species) are worth wile to extract. This means that per-hectare extraction values in remote, biologically diverse and abundant forest environments will almost inevitably be low, thus limiting the economic potential of sustained forest extraction from those sites [see Southgate (1998)]. To a certain extent, an insoluble conflict rules in most tropical forests between biodiversity and the long-run feasibility of commercial direct uses, between ecology and the economics of sustained market-oriented product extraction. More generally, a characterisation by Curtis H. Freese may apply: "Natural ecosystems and commercial markets are uneasy bedfellows" [see Freese (1998, p. 134)].

This general verdict may of course be qualified for different geographical areas and for each of the products concerned. Table 7 provides a preliminary overview of the non-timber extraction products with the highest economic values. Social and ecological indicators in Table 7, although much more tentative (some of them have question marks attached), are based on the literature review and some field observation. Obviously, in-depth studies of these aspects would need to be incorporated to complement this overview. Also, additional indicators may supplement the picture, e.g. certain market characteristics, such as the existence of close (natural or synthetic) substitutes of the product in question.[55] Nevertheless, two or three "clusters" of products can be identified from Table 7.

First, selected palm products, like babassu, assai, piassava and carnauba, already generate medium to high income flows, thanks to their abundance in specific sites, although their per-hectare returns seem to be variable. Extraction scales (as expressed in Table 1) also vary, from predominantly small-scale (babassu) to large-scale producers (piassava), which is likely to have quite different income distribution implications. The cultivation share generally seems to have remained low, mostly because of moderate product demand compared to their natural abundance and regrowth, specifically in intervened areas. A marked rise in demand for these products would therefore also stimulate higher extraction and extractive incomes, at least in the short run. In many of those intervened areas, the respective palms dominate the pioneer vegetation where they preferentially occur, often characterised by low biodiversity. As the bottom line (last two rows in Table 7), medium to high potential of the palm products for rural income generation is in contrast with a low potential for adding value to biologically diverse forest ecosystems. This limitation is due to their harvesting being restricted to "special" ecological settings, so that their contribution to natural forest conservation is bound to be "site-restricted".

Maté is a product that shares some of the palm product characteristics (high income potential, medium extraction scale), but cultivation has progressed much more, probably much due to the higher competition between alternative land uses in the Brazilian south where it grows. It is likely that the bulk of any further demand expansion in the future would be satisfied by cultivated areas were returns are superior. However, a continuum of "soft management" techniques exists to increase extractivist production, too. It is a plant that grows densely in a "genuine" natural forest environment (Araucaria forests), and hence extraction seems to occur from areas with a higher biodiversity than the palm belts. Maté thus occupies an intermediate position between the two product clusters in Table 7.

[55] An example of an NWFP market assessments is the work done by the Natural Resources Institute (NRI), on Brazilian gums, resins and insecticides, providing a rather pessimistic outlook [see Coppen et alii (1994); Gordon and Coppen (1993)].

Table 7

The seven main plant extraction products – a tentative classification of economic, social and biological characteristics

Plant	Babassu	Assai (cabbage palm)	Piassava	Carnauba
Main *use*	Almonds/ oil	Fruits/ hearts	Fibres	Wax/ powder
Total income size [Trend]	High [fluctuating]	High [rising]	High [declining]	Medium [fluctuating]
Average per-hectare income	High	High	Medium	Low
Extraction income per establishment	Low	Medium	High	Medium
Cultivation share	Near zero	Near 25%	Near zero	Near zero
Higher demand raises extraction?	Yes	Yes	Yes	Yes
Predominant vege-tation of origin	Pioneer	Riverside areas	Pioneer	Pioneer
Average per-ha plant frequency	High	High	High	High
Likely average biodiversity	Low	Low	Low	Low (?)
Potential to raise rural incomes and reduce poverty	Quite good	Good	Restricted	Quite good (?)
Potential to raise the value of natural forests	Site-restricted	Site-restricted	Site-restricted	Site-restricted

Plant	Maté	Brazil nut	Hevea
Main use	Tea/soft drinks	Foodstuff	Coagulated rubber
Total income size [Trend]	High [increasing] (?)	Low [fluctuating]	Low [declining]
Average per-hectare income	High	Low	Low
Extraction income per establishment	Medium	Low	Medium
Cultivation share	near 50%	near zero	near 95%
Higher demand raises extraction?	Little	Yes	Negligibly
Predominant vege-tation of origin	Araucaria forest	Closed rainforest	Closed rainforest
Average per-ha plant frequency	High	Low	Low
Likely average biodiversity	Medium (?)	High	High (?)
Potential to raise rural incomes and reduce poverty	Good	Value-restricted	Value-restricted
Potential to raise the value of natural forests	Intermediate	Value-restricted	Value-restricted

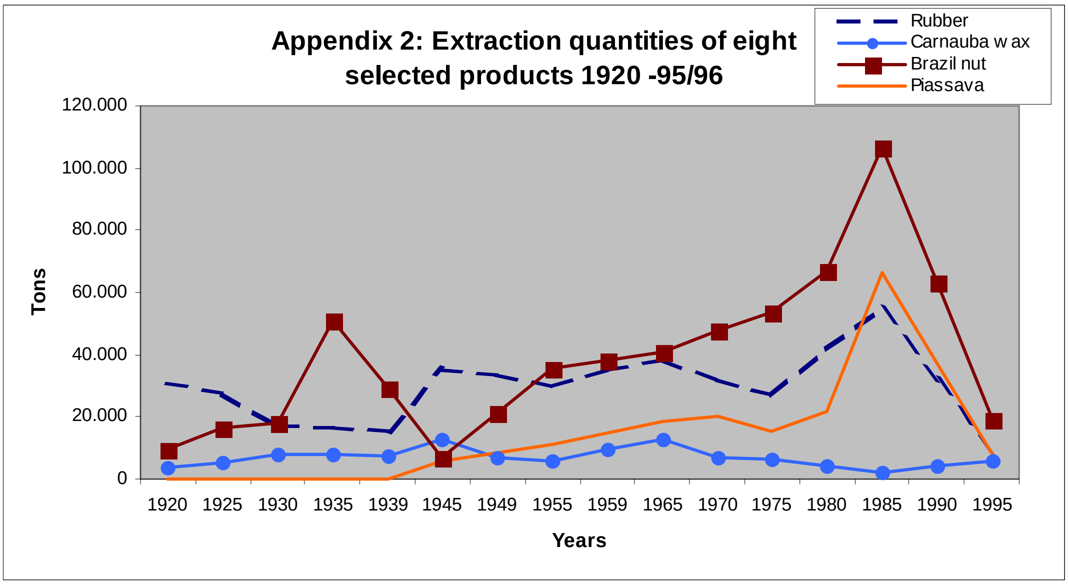
On the other end of the scale, we have what simplified could be called the "true rainforest products", rubber and Brazil nuts, generated normally in forest extraction areas with high biodiversity. Average extraction scale is small for Brazil nuts and medium for rubber. Unfortunately, the income flows from these products are very limited, and are likely to remain so in the future. For rubber, the structural decline of extractivism seems irreversible, as cultivation and synthetic substitutes by now appear to have "won the race" for market domination. For Brazil nuts, cultivation has remained highly limited by the slow growth of the tree, but cultivated competitors in the international edible nut markets have increasingly won ground. Per-hectare returns for both products are extremely low, so the market-based (unsubsidised) economic feasibility of their extraction is restricted to land-abundant environments with low labour costs and few land conversion alternatives. On the other hand, in these areas they may provide an important complementary income. If promoted successfully in a "green niche" of Northern markets, these local incomes may even rise significantly. However, on aggregate, the wider potential of those rainforest products for both poverty reduction and for contributing significantly to forest conservation is "value-restricted": normally, they are not able to generate sufficient income to change the prevailing economic logic of forest conversion.

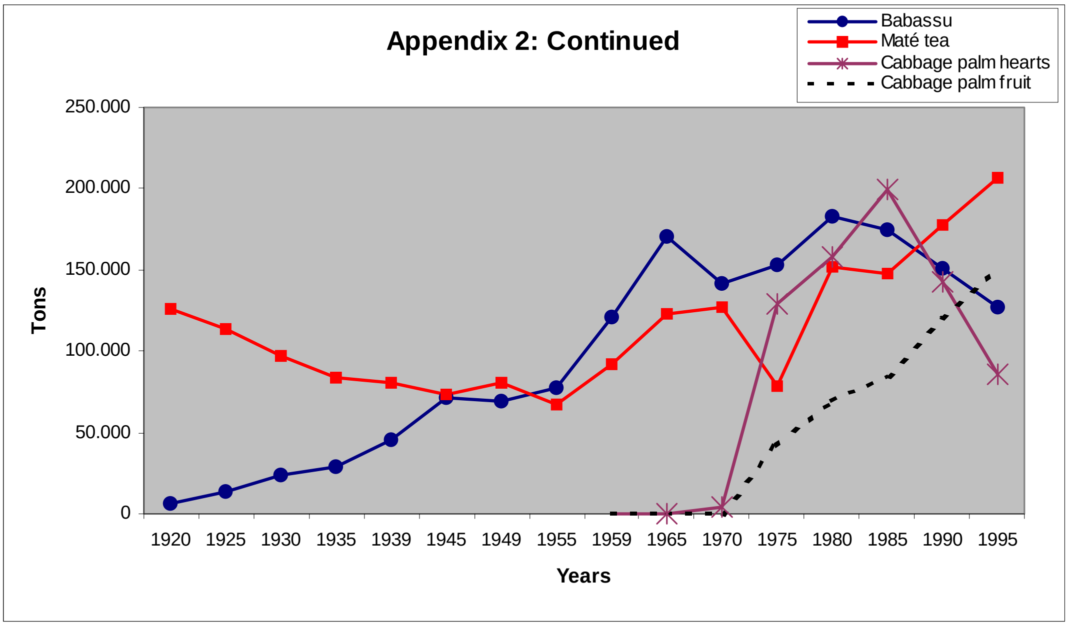
This observation invites a closing comment. In general, some of the results in this study have confirmed the so-called "inferiority" of forest extractivism. However, this finding does not mean that extractivism should be neglected across the board, or even actively discouraged. It still facilitates a steady flow of new products that are gradually integrated into the market economy, as an intermediate phase between biodiversity's "option values" and the stage of full commercial (domesticated) integration. It also provides some complementary income for highly capital-scarce producers in land-abundant environments — a setting that is applicable to many marginal or frontier areas. However, a gradual transition from extractivism to cultivation is likely to occur for most products, and even for most places of extraction. It is difficult, if not impossible, to swim against this tide. The speed of this transition depends on the abundance of supply from natural vegetation (e.g. carnauba, piassava), on the options of "soft management" to increase extractive returns (e.g. maté) and on the rise in product demand (e.g. cashew). Barriers to cultivation often appear to be technical, but the real decision parameters tend to be deeply embedded into the sphere of economic incentives: if sufficient profitability and market prospects exist, investments in research and development of cultivation techniques will often solve what previously was perceived as an insurmountable technical hurdle. For instance, this is why cashew and rubber are now cultivated on a large scale, while carnauba and Brazil nuts are not.

Although many products pass on to cultivation phases, new ones will arise from the pool of resources that the forest and other natural ecosystems continue to provide, whenever niches in the market are identified and exploited.[56] It is important to consider these “option values” provided by the reservoir of biological diversity in natural forests in an economic sense, as an externality to the economic returns of exploitation here and now. In many forest-rich and agricultural-frontier type areas, even apparently small per-hectare returns from large forest extraction areas may provide valuable *partial contributions* to household’s livelihoods and to the economic feasibility of forest conservation strategies. On the other hand, based on the present findings, it would indeed seem unlikely that such strategies can use plant extractivism as a sustained economic cornerstone.

[56] Some sources, like Genesys (1994), over-estimate this potential, by assuming that there are almost no limits to the market introduction of new, forest-extracted products. The experiences from Amazon agroforestry show that a high price elasticity in local and national markets may constitute a severe constraint to expanding supply [Smith et alii (1998)].

Append 1


Appendix 2: Extraction quantities of eight selected products 1920 -95/96
Rubber
Carnauba w ax
Brazil nut
Piassava
Tons
120.000
100.000
80.000
60.000
40.000
20.000
0
1920 1925 1930 1935 1939 1945 1949 1955 1959 1965 1970 1975 1980 1985 1990 1995
Years


Appendix 2: Continued
Babassu
Maté tea
Cabbage palm hearts
Cabbage palm fruit
Tons
250.000
200.000
150.000
100.000
50.000
0
1920 1925 1930 1935 1939 1945 1949 1955 1959 1965 1970 1975 1980 1985 1990 1995
Years

Appendix 3

Plant extraction share in establishments' agricultural income

Percentage distribution of income brackets, per federal state

Federal states	Total	0%	0%-1%	1%-5%	5%-15%	15%-30%	30%-50%	50%-75%	Above 75%
Rondonia	100.0	35.78	20.42	27.80	10.06	2.86	1.17	0.61	1.29
Acre	100.0	32.47	16.03	18.14	13.52	8.76	5.94	3.01	2.13
Amazonas	100.0	38.40	7.65	23.54	14.80	6.30	3.51	2.04	3.76
Roraima	100.0	70.52	2.66	11.09	9.63	3.20	0.99	0.76	1.15
Para	100.0	19.66	7.68	21.88	20.53	9.47	5.23	5.11	10.45
Amapa	100.0	48.10	19.98	10.15	4.21	3.37	2.45	2.36	9.38
Tocantins	100.0	18.69	16.66	31.88	18.60	5.76	2.18	0.98	5.25
Maranhao	100.0	36.20	2.09	9.98	15.54	12.44	10.04	7.85	5.86
Piaui	100.0	44.56	4.30	17.32	16.85	8.75	4.68	2.46	1.08
Ceara	100.0	43.17	3.99	18.15	20.32	9.21	3.38	1.17	0.61
Rio Grande do Norte	100.0	78.70	2.12	6.73	6.46	3.03	1.28	0.69	0.99
Paraiba	100.0	72.49	2.88	11.05	8.84	3.09	1.11	0.37	0.17
Pernambuco	100.0	74.72	2.73	8.73	8.22	3.48	1.39	0.50	0.22
Alagoas	100.0	98.51	0.27	0.47	0.37	0.18	0.10	0.05	0.05
Sergipe	100.0	89.09	1.21	3.13	2.95	1.68	0.74	0.44	0.76
Bahia	100.0	75.66	1.86	6.48	7.28	4.13	2.22	1.24	1.14
Minas Gerais	100.0	70.88	4.96	10.13	8.00	3.38	1.40	0.66	0.59
Espirito Santo	100.0	87.16	5.89	5.07	1.28	0.33	0.12	0.04	0.11
Rio de Janeiro	100.0	98.94	0.45	0.44	0.11	0.02	0.01	0.01	0.02
Sao Paulo	100.0	98.98	0.22	0.31	0.24	0.10	0.05	0.03	0.08
Parana	100.0	66.58	8.91	14.57	6.07	1.92	0.92	0.48	0.54
Santa Catarina	100.0	53.89	14.26	20.26	7.90	2.06	0.84	0.42	0.37
Rio Grande do Sul	100.0	55.20	13.54	21.44	7.56	1.51	0.44	0.15	0.16
Mato Grosso do Sul	100.0	82.97	7.17	4.06	2.72	1.33	0.74	0.43	0.59
Mato Grosso	100.0	79.70	5.03	7.33	3.97	1.48	0.75	0.53	1.21
Goias	100.0	74.32	10.39	9.86	3.48	1.02	0.37	0.19	0.37
Federal District	100.0	99.92	0.04	0.00	0.00	0,00	0.04	0,00	0.00
Brazil	100.0	63.08	5.70	12.25	9.28	4.37	2.34	1.46	1.52

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