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ARTICLE

Anatomy of babassu-nut value chain for policy guidance in support of traditional agroextractive communities in the Mearim Valley, Maranhão, Brazil

Anatomia da cadeia de valor do babaçu para suporte a políticas públicas voltadas a comunidades tradicionais agroextrativistas no Vale do Mearim, Maranhão, Brasil

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Abstract: Babassu-nuts are one of the most important socio-biodiversity products in Brazil. Detailed and reliable information on the babassu value chain is essential for local and regional public policies to support the economy associated with the extraction of this product and vulnerable social groups that depend on it for survival. This study presents a methodology to analyze the babassu value chain and discusses results obtained in 2021 from the application of this methodology in Vale do Mearim, Maranhão, the region with the highest babassu production in the country. The study contributes to the evaluation of the accuracy of official statistics on production and involvement in babassu extractive activity and discusses implications for the most relevant public policy for non-timber forest products in Brazil, the Minimum Price Policy for Socio-biodiversity Products (PGPM-Bio). In a territory comprising 25 municipalities, we interviewed about 640 local traders, who purchased 6,000 tons of almonds from 9,000 extractivist families, with an annual average of 661 kg per family. These local traders passed the production to 23 regional traders, who transported it to 11 industrial pressing units for oil production, 8 of them located in the same territory. According to the field research, the volume commercialized corresponds to 27% of the official estimate for the previous year, denoting a reduction in production and in the number of persons engaged in extraction activity much higher than the downward trend indicated by official statistics. Considering that determining the Gross Domestic Product of municipalities, as well as planning and monitoring the implementation of policies such as PGPM-Bio should take into account outreach indicators based on official statistics, the analyses suggest reviewing procedures to obtain annual estimates of babassu extraction.

Keywords: *Attalea speciosa*, bioeconomy, non-timber forest product, sociobiodiversity.

Resumo: As amêndoas de babaçu são um dos mais relevantes produtos da sociobiodiversidade no Brasil. Informação detalhada e confiável sobre a cadeia de valor do babaçu é fundamental para políticas públicas de âmbito local e regional, em apoio a uma economia associada à extração deste produto e a grupos sociais vulneráveis que dele dependem para a sobrevivência. Este estudo apresenta metodologia para analisar a cadeia de valor do babaçu e discute resultados obtidos em 2021 com a aplicação desta metodologia no Vale do Mearim, Maranhão, território de maior produção de babaçu no país. O estudo contribui na avaliação da acurácia de estatísticas oficiais sobre produção e envolvimento na atividade extrativa do babaçu e discute implicações para a política pública mais relevante a produtos florestais não madeireiros no Brasil, a Política de Preços Mínimos para Produtos da Sociobiodiversidade. Em território que compreende 25 municípios, foram entrevistados cerca de 640 comerciantes locais que adquiriram 6 mil toneladas de amêndoas de 9.000 famílias extrativistas, com média anual de 661 kg por família. Estes comerciantes locais repassaram a produção para 23 comerciantes regionais, que a transportaram para 11 unidades industriais de prensagem para fabricação de óleo, 8 delas localizadas no mesmo território. De acordo com a pesquisa de campo, o volume comercializado corresponde a 27% da estimativa oficial para o ano anterior, denotando redução na produção e número de extrativistas que exercem a atividade muito superior à tendência descendente

indicada pelas estatísticas oficiais. Considerando que a determinação do Produto Interno Bruto dos municípios, assim como o planejamento e monitoramento da execução de políticas como a PGPM-Bio devem levar em consideração indicadores de alcance baseados em estatísticas oficiais, as análises sugerem a revisão de procedimentos para obter estimativas anuais sobre o extrativismo do babaçu.

Palavras-chave: *Attalea speciosa*, bioeconomia, produto florestal não madeireiro, sociobiodiversidade.

1. Introduction

The nuts of the babassu palm (*Attalea speciosa* Mart. ex Spreng.) are one of the main non-timber forest products (NTFP) of Brazilian socio-biodiversity (Anderson et al., 1991; Pinheiro, 2004; Porro, 2019). Since the 1940s, babassu-nuts have been considered among the most economically important extractive products in the country (Amaral Filho, 1990; May, 1990). In fact, the largest financial allocation of the Minimum Prices Policy for Socio-biodiversity Products (PGPM-Bio), the most relevant policy addressing NTFPs in Brazil, is channeled to babassu-nuts. The babassu palm occurs in low densities in natural, primary forests, where they form oligarchic forests (Peters et al., 1989) that dominate the landscape in secondary succession that, as early as the 1980s, reached nearly 200,000 km^2. In areas with extensive cattle pasture, the palm tree is associated with forage species in silvo-pastoral systems.

Babassu-nuts are obtained from the work of one of the most active social groups among traditional communities in Brazil. The so-called "babassu-nut breakers" (*quebradeiras de coco babaçu*) have gained visibility by effectively integrating socio-environmental practices and discourses in the struggle for their livelihoods (Porro et al., 2011; Shiraishi Neto, 2017; Barbosa, 2018). In recent decades, however, official statistics reveal a sharp reduction in the economic extent of babassu-nut extraction (Instituto Brasileiro de Geografia e Estatistica, 2006, 2017), with associated economic, social, and environmental implications.

Since the 1980s, several factors explain the reduction in engagement in babassu extraction, including transformations in the oilseed market for industrial processing, the expropriation of traditional communities and the conversion of babassu groves into pastures where palms are eliminated to avoid encroachment by peasant families (Hecht et al., 1988; May, 1990; Porro, 2005, 2022). Even in family farming areas, the remaining secondary forests of babassu palms come under pressure that did not exist when land was abundant for long fallow periods (Porro & Porro, 2015). Progressive reduction in the number of women working as babassu-nut breakers, and/or in the time they dedicate to the activity, is partly due to their access to a minimum income from conditional cash transfers (Gomes et al., 2021). Especially for young women, the hardship of the job, combined with low economic returns, contributes to their lack of interest in dedicating themselves to an activity that was key to the livelihoods of their mothers and grandmothers. In addition, an increased number of companies are setting up industrial plants for processing whole fruits of the babassu palm and installing stations for purchasing babassu whole fruits in rural areas, thus displacing women from their nut-breaking activity (Porro, 2019).

Recent official data on babassu-nut extraction has, however, shown discrepancies (Porro, 2022). The volume of babassu-nuts reported by the Brazilian Bureau of Geography and Statistics (IBGE) in recent annual estimates of the Production of Plant Extraction and Silviculture (PEVS) is much higher than reported in the 2017 Agricultural Census. In part, this is expected since the census is conducted only in agricultural landholdings and may not include landless rural households practicing babassu extraction. PEVS data are not derived from the census, being estimated from informants connected to each of the respective value chains. Notwithstanding

the available knowledge of these informants, some estimates may not capture trends and specificities in the actual production sites.

In recent years, despite decreasing production caused by territorial losses, devastation of babassu groves, and income inflow from social policies, initiatives by babassu-nut breakers have sought to reverse this trend through collective organization networks aimed at accessing the economic subsidy provided by PGPM-Bio (Diniz et al., 2020; Oliveira, 2020). Such initiatives indicate positive responses in terms of the volume of babassu-nuts produced once higher prices compensate their work.

This study presents a methodology to assess the value chain of babassu-nuts and analyzes results obtained from the application of this methodology with traders responsible for the acquisition of this production in municipalities that stand out as the area with the largest production of babassu-nuts in Brazil, the Mearim Valley, in the state of Maranhão. Similarly to what applies to other major products of Brazil's socio-biodiversity, such as Brazil-nut (Krag & Santana, 2017) and açaí berry (Santana et al., 2017), obtaining detailed and reliable information on babassu extractive production, as well as understanding how this value chain operates, is fundamental for the definition of local and regional policies to support initiatives based on the bioeconomic potential around this important NTFP and the vulnerable social groups that rely on it for their survival.

Following these opening remarks, we present an overview of the bioeconomy paradigm, focusing on the need for an inclusive bioeconomy of socio-biodiversity products. We then describe in detail the methodological procedures adopted in this study, followed by the presentation of results of their application in the Mearim Valley. Next, the configuration of the value chain of babassu-nuts in the studied area is presented. Finally, we discuss the implications of these results for the most relevant policy for NTFPs in Brazil, and highlight the need to improve the accuracy of official statistics related to babassu extraction activity.

2. Theoretical foundation

Socio-biodiversity is a concept comprising the relationship between biological diversity and the use and management of these resources through the knowledge and culture of indigenous peoples, traditional communities and family farmers. In 2009, Brazil's National Plan for the Promotion of Socio-biodiversity Product Chains (PNPSB) was created to strengthen sustainable markets for non-timber forest products. This policy reaffirmed the notion of socio-biodiversity products, defined as "goods and services (end products, raw materials or benefits) generated from biodiversity resources, aimed at the formation of productive chains of interest to traditional peoples and communities and family farmers, which promote the maintenance and enhancement of their practices and knowledge, and ensure the resulting rights, generating income and promoting the improvement of their quality of life and of the environment in which they live" (Brasil, 2009). Livelihoods derived from babassu forests that spread out in the transition zone between the Amazon and Cerrado biomes are directly connected to a key component of Brazil's socio-biodiversity.

The concept of socio-biodiversity has been increasingly incorporated into the bioeconomy paradigm, which is widely discussed as an important approach to address major global challenges through a sustainable and renewable bio-based economy. According to the Food and Agriculture Organization of the United Nations (FAO), bioeconomy is the "production, utilization and conservation of biological resources, including related knowledge, science, technology and innovation, to provide information, products, processes and services in all

economic sectors, aiming at a sustainable economy". The bioeconomy was conceived on the basis of applying biological principles and processes in all sectors of the economy to replace fossil fuels with bio-based resources and principles. The term became popular in the first decade of the 21st century from its use by the European Union (EU) and the Organization for Economic Cooperation and Development (OECD) as a framework for promoting the use of biotechnology to develop new products and markets. Innovative and sustainable use of biological resources in different sectors of the economy (i.e., a biological transformation) would offer opportunities for achieving different Sustainable Development Goals (SDGs) through sustainable solutions to address current climate change risks (De Besi & McCormick, 2015). Dietz et al. (2022) distinguish between four main bio-based transformation pathways: 1. substitution of fossil fuels with bio-based feedstocks; 2. increased productivity in bio-based primary sectors; 3. increased efficiency in biomass utilization; and 4. creation and addition of value through the application of bio-based principles and processes other than large-scale biomass production. By comparatively analyzing the governance of these bioeconomy pathways, the authors indicate that, despite objectives associated with sustainability, conflicting goals are related to their development.

Indeed, in a study presenting recommendations for policies aimed at the development of a bioeconomy based on native forest and socio-biodiversity, Costa et al. (2021) discuss three trajectories organized around the concept of bioeconomy: biotechnological, bioresource, and bioecological bioeconomies. The biotechnological path emphasizes the importance of research for innovations in bio-based processes, which can be appropriated in different sectors of the economy, such as biorefineries. The second path, characteristic of the European discussion of bioeconomy, emphasizes the substitution of industrial inputs from non-renewable sources for those derived from renewable biological resources. According to the authors, these two paths are based on mass production and gains of scale, aligned with the dominant technological paradigm of mechano-chemical solutions. The bioecological pathway, or bioeconomy of socio-biodiversity, prizes ecological processes that optimize the use of energy and nutrients based on biodiversity (Bugge et al., 2016) in a perspective of harmony with the original nature, managing the diversity of botanical systems and their autonomy from exogenous sources of energy and nutrients.

Authors of the Bioeconomy section in the Scientific Panel for the Amazon (SPA) highlight academic contributions suggesting that, beyond an economic sector, the bioeconomy can and should be considered as an ethical-normative imperative; that is, as an essential value to achieve the goal of humanity living in harmony with nature (United Nations, 2010). A contemporary bioeconomy will thus increasingly rely on ethical and normative precepts aimed at transforming society toward sustainable development paths, an achievement that must be supported by science and technology in order to repair the current destructive relationships between society and nature (Abramovay et al., 2021). The authors emphasize that, in tropical forests, approaching the bioeconomy as a value means that economic activities, despite their great variety of sectors, actors and technical resources, must strengthen the socio-biodiversity of the forest and improve the living conditions of the people who inhabit these territories. They highlight a strong contrast with temperate countries, in which the references for the bioeconomy arise in environments whose biological diversity is much less complex than in tropical forests and argue for an approach that makes it possible to improve living conditions through in-depth knowledge of nature (Abramovay et al., 2021).

Some of the main challenges to enabling a new bioeconomy include harnessing the potential of tropical forests without destroying them, converting their regeneration into an engine of economic growth, combining scientific knowledge with the knowledge systems of local people,

and transforming the production and marketing of commodities in ways that can be integrated into ecosystem strengthening. Thus, public policies and actions aimed at the sector should favor the emergence of a bioeconomy that contributes to raising the level of human development, expanding the use and exploiting the multiplier potential of biodiversity, stimulating investments in environmentally sensitive infrastructure that meets people's needs, as well as strengthening the scientific and technological knowledge necessary for the forest economy to become the epicenter of development, through an economic matrix that favors the expansion of socio-biodiverse areas (Abramovay et al., 2021).

3. Methodology

The study aimed to obtain reliable information on the babassu-nut value chain, with greater focus on hundreds of local traders situated in rural communities or villages. These traders constitute the first step in the commercialization of the production sold by thousands of extractivist families. The study also examined the operation of regional traders that channel this production to babassu-oil processing plants in the study area and elsewhere, as well as the commercial procedures of processing plants directly engaged in the regional market. Previous research in the study area had clarified features of the value chain, such as the limited role of suppliers (supplying only basic tools, such as the axes used by extractivist families to crack the babassu fruit). The important role played by Brazil's National Supply Company (Conab) for PGPM-Bio's bonus payment (to be discussed after the presentation of results) contrasted with the near absence of other relevant players in the institutional environment. Indeed, the limited presence of other institutions contributes to the inaccuracy of official statistics of the babassu-based economy, as will be further analyzed in this article.

Over six years, starting in 2016, research protocols were gradually applied in 25 municipalities of the Mearim Valley. In the present study, the designation 'Mearim Valley' comprises 25 municipalities in which data were collected (Figure 1). Of these, 17 are in Brazil's geographic microregion defined by IBGE as Médio Mearim (GM-MM), which includes a total of 20 municipalities. Another three municipalities are part of the Territory of Citizenship of the Médio Mearim (TC-MM), established in 2009 by the federal government, comprising 16 municipalities, of which only these three are not part of the GM-MM. The other five municipalities in which the study was carried out belong to contiguous microregions (Codó and Pindaré) with strong economic and cultural integration. The study did not include one municipality located in the southern portion of the GM-MM and TC-MM (São Raimundo do Doca Bezerra) where the occurrence of babassu palm and its extraction is negligible.

In the first year the study was conducted only in Lago do Junco and Lago dos Rodrigues, selected due to the location of the Cooperative of Small Agro-extractive Producers of Lago do Junco (Coppalj). Founded in 1991, the cooperative provides new perspectives of access to babassu-derived income for its members (Vicari, 2014; Nascimento & Porro, 2022). Coppalj is a key organizational player in the regional value chain of babassu, with detailed information on the market of babassu-nuts, contributing to the adjustment of protocols used in the present study. In the following years, the survey was conducted in 6 (2017), 10 (2018), 18 (2019 and 2020) and 25 (2021) municipalities. According to the 2017 Agricultural Census, about 45% of babassu-nuts in Brazil originate from these 25 municipalities.

Monitoring the production purchased by all local traders in the 25 municipalities serves to gauge official data generated by IBGE, identifying possible distortions of a production that tends to be accounted for in PEVS official estimates for municipalities where final commercialization

and processing occurs, rather than in the actual production sites. The volume of babassu-nuts thus tends to be overestimated in larger municipalities where production is channeled, in operations with little formality. The methodological steps and components of the study conducted are described below.

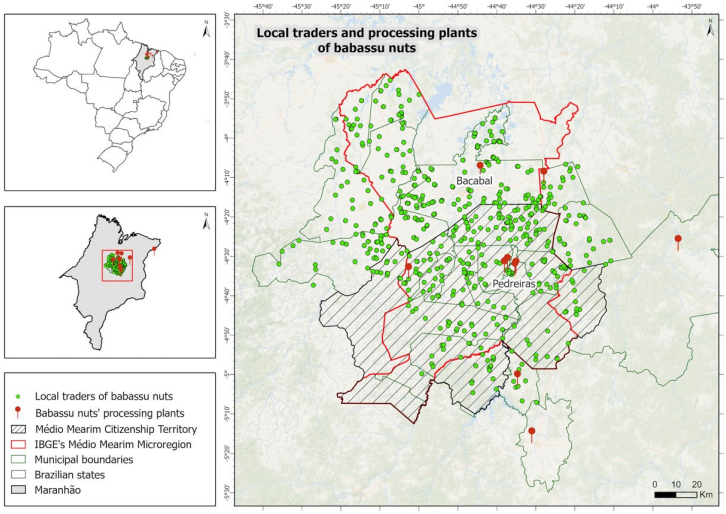

Figure 1. Local traders of babassu-nuts and babassu-oil processing plants, Mearim Valley.

Mapping of commercialization points occurred in meetings to outline the strategy for field execution, in which available maps were used showing the location of villages and access roads. Planning of data collection routes was guided by key informants with knowledge of the territorial reality and the location of babassu marketing points.

Commercialized production was registered in forms filled out in interviews with traders that purchase nuts and other babassu products. In addition to the estimated volume and price of nuts and the number of babassu-nut breakers, the form contextualizes the commercial post: age of the person in charge and year in which activity started; modality of acquisition (cash only and/or in exchange for foodstuff and basic goods); other babassu products acquired (charcoal, husk, whole fruit, oil, starch); production destination (regional trader to whom the babassu-nuts are sold); number of extraction workers who sell with that trader with the intention of accessing PGPM-Bio's economic subsidy; geographic coordinates; and telephone number. During the year, three interviews were conducted with each local trader, but contextualization questions were asked only in the first interview. During this visit, a document for informed consent regarding the activity was read and given to the person interviewed. To reduce the risks of inaccurate information due to weak memory recall, interviews were conducted quarterly.[1]

A database to store information and enable further analysis was generated through a software application customized for this study for web and mobile platforms, which allows the creation of questionnaires and the management of information. The software uses Apache/PHP technology for reading and interpreting the source code, and MySQL for data persistence, allowing data to be filled in an application installed on tablets, even in the offline environments predominant in field locations. In this case, data stored in the device are synchronized with the server when access to the internet is provided. The questionnaire-filling module has an interface similar to a physical form, in which data are typed and edited. If information is recorded on paper it can

[1] In 2020 and 2021, due to the Coronavirus pandemic, methodological adjustment was necessary, and interviews were conducted every six months.

be later typed into the system. The database can be fed progressively, and once completed the data is exported for statistical analyses.

Database information is accessed through .csv files. *Descriptive and analytical reports* are obtained from spreadsheets or statistical programs, while geographical coordinates allow the spatialization of the value-chain and its integration into geographic information systems.

4. Results and discussion

Figure 1 shows the 25 municipalities covered by the study and the location of the local traders of babassu-nuts where interviews were conducted in 2021, in addition to the processing plants to which this production is channeled. Seven of these local traders are based in a given municipality but operate by trucks, traveling through commercialization routes in neighboring municipalities, acquiring the production directly from extracting families. By consolidating into a single business the multiple municipalities in which each of these individuals operates, the total number of local traders amounts to 628.

4.1. Characterization of babassu-nut local traders.

The average age of people in charge of the 639 commercial businesses where interviews were conducted in 2021 was 56 years, and the activity had been carried out for an average of 20 years. The vast majority of businesses do not purchase any other babassu products besides nuts. The whole babassu fruit is purchased by 40 traders (6%), who make this production available to babassu-nut breakers living in the village, who extract the nuts from the babassu fruit. Traders retain the wooden husk (endocarp) to be sold, usually as fuel for industries such as ceramics or breweries. Commercialization of the husks of the babassu fruit is quite relevant in the studied area, but it takes place through other routes than the traders of babassu-nuts. The purchase of husks was registered only by six of these traders, while 5% buy charcoal made from husks, and only eight buy locally produced babassu oil. Some 63% of the traders use cash to purchase babassu-nuts, while 37% accept the nuts as payment for foodstuff and basic goods they sell.

In Table 1, the commercial businesses are distributed according to five classes defined by the annual volume purchased. The table indicates that traders purchasing up to 6 tons of babassu-nuts per year comprise more than 50% of the total, but account for only 18% of production. The 22 locations (3.5% of the total) whose volume exceeds 36 tons per year move about 23% of the total, and seven of these locations are linked to Coppalj. Municipalities with the largest number of traders are Bacabal (112) and São Luís Gonzaga do Maranhão (100), followed by Bom Lugar (37), Paulo Ramos (36), Vitorino Freire (35), and Peritoró (30).

Table 1. Commercial traders according to the 2021 volume of purchased babassu-nuts.

	Volume of babassu (t) purchased in 2021					
	≤ 6	6-12	12-24	24-36	≥ 36	Total
Locations	326 51.0%	183 28.6%	86 13.5%	22 3.4%	22 3.4%	639 100%
t of babassu nuts	1,094,873 18.3%	1,494,093 24.9%	1,422,562 23.7%	649,015 10.8%	1,334,577 22.3%	5,995,119 100%

4.2. Annual volume commercialized, prices paid, and production value.

Table 2 summarizes results obtained from the field survey in all municipalities between 2016 and 2021. Figure 2 shows the monthly variation of the volume of babassu-nuts sold to local traders. Lower volume was observed between March and August (44%), contrasting with higher volumes from September to February (56%).

Table 2. Volume and value of babassu-nuts sold, and average price paid to families in the Mearim Valley municipalities (2016-2021).

	2016	2017	2018	2019	2020	2021
Number of municipalities	2	6	10	18	18	25
Annual volume (t of nuts)	1,470.0	2,588.0	3,590.6	5,247.3	4,747.4	5,995.1
Production value (1,000 US$)	656.6	1,594.5	1,774.7	1,485.3	1,609.2	2,974.7
Average price of nuts (US$/kg)	0.45	0.62	0.49	0.28	0.34	0.50

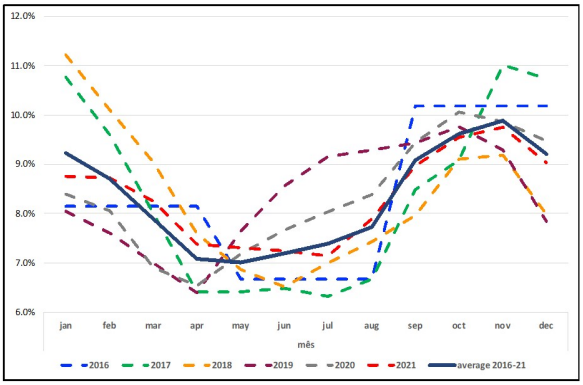

Figure 2. Monthly proportion of babassu-nuts sold in the Mearim Valley (2016-2021).

The price of babassu-nut tended to be higher between July and December (Figure 3), the peak production period. This occurred in 4 of the 6 years of the research period (2016-2017 and 2020-2021), while little variation occurred in 2019. A relative increase in the price of babassu-nuts was observed throughout 2017, followed by 2018's downward trend. The already low prices at the end of 2018 further decreased in early 2019, and price stagnation lasted until mid-2020. Prices started to rise gradually half-way through that year and peaked in September 2021.

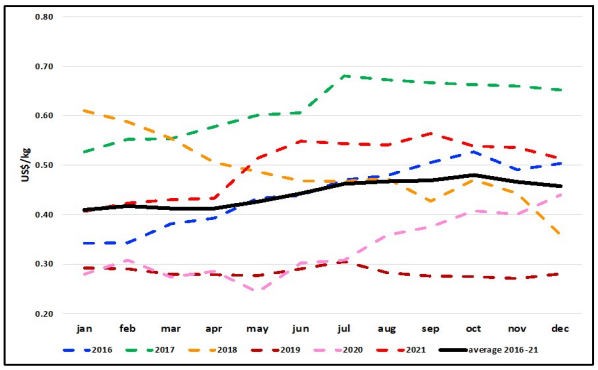

Figure 3. Average monthly price of babassu-nuts in the Mearim Valley (2016–2021); US dollar figures based on exchange rates for the 15th day of each month.

The nature of this oscillation is seen in Figure 4. Prices paid to families in Brazilian currency are compared to subsidized minimum prices set up by Brazil's National Supply Company (Conab) for PGPM-Bio's bonus payment, which was adjusted every other year.

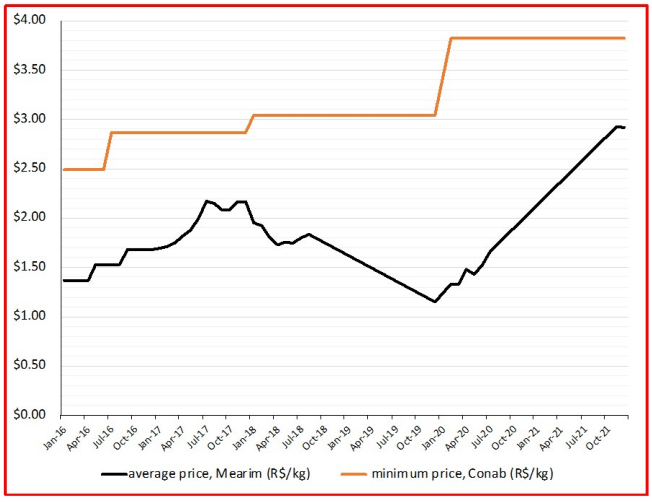

Figure 4. Babassu-nut average price (Mearim) and Conab's minimum price (2016–2021).

Table 3 introduces 2021 figures of commercialized babassu-nuts in each of the 25 municipalities. About 46% of this total derives from four municipalities: Bacabal, São Luís Gonzaga, Lago do Junco and Lago dos Rodrigues. The average annual price paid by the cooperative Coppalj for Babassu-nuts in 2021 (US$ 0.62/kg) turned out to be 29% higher than the overall average price in all other locations (US$ 0.48/kg).

Table 3. Volume (t), total value (US$), and average price (US$/kg) paid to babassu-nut breakers for production traded in Mearim Valley municipalities (2021).

Municipality	Volume (t)	Value (US$)	Mean price (US$/kg)	Families	Kg/fam/year
Alto Alegre do Maranhão	129.9	54,726	0.42	314	414
Bacabal	868.7	467,973	0.54	1,082	803
Bernardo do Mearim	229.8	115,540	0.50	255	901
Bom Lugar	275.4	146,777	0.53	242	1,138
Capinzal	79.8	48,315	0.61	120	665
Esperantinópolis	111.5	38,825	0.41	240	464
Igarapé Grande	202.8	105,046	0.52	231	878
Joselândia	231.9	113,067	0.49	277	837
Lago da Pedra	90.5	44,180	0.49	131	691
Lago do Junco	137.5	58,692	0.43	178	773
Lago dos Rodrigues	82.4	37,608	0.46	101	816
Coppalj*	668.1	416,845	0.62	1,266	528
Lima Campos	114.9	59,912	0.52	191	602
Olho D'Água das Cunhãs	140.1	62,312	0.44	238	589
Paulo Ramos	267.7	97,352	0.45	392	683
Pedreiras	50.6	29,236	0.58	129	392

* Data from Lago do Junco and Lago dos Rodrigues excludes production from Coppalj. The cooperative is active in both municipalities and its production is reported separately.

Table 3. Continued...

Municipality	Volume (t)	Value (US$)	Mean price (US$/kg)	Families	Kg/fam/year
Peritoró	203.6	97,766	0.48	313	650
Pio XII	141.5	63,988	0.45	297	476
Poção de Pedras	216.5	88,482	0.41	401	540
Santo Antônio dos Lopes	73.8	44,010	0.60	102	723
São José dos Basílios	52.8	28,069	0.53	87	607
São Luís Gonzaga do MA	1,018.1	475,133	0.47	1,526	667
São Roberto	12.1	5,629	0.47	16	756
Satubinha	110.0	52,097	0.47	110	1,000
Trizidela do Vale	201.2	94,771	0.47	378	532
Vitorino Freire	283.9	128,373	0.45	450	631
Total	**5,995.2**	**2,974,724**	**0.50**	**9,067**	**661**

* Data from Lago do Junco and Lago dos Rodrigues excludes production from Coppalj. The cooperative is active in both municipalities and its production is reported separately.

4.3. Engagement in babassu extraction.

In 2021, babassu-nut breakers from more than 9,000 households sold their production to 639 local traders in the 25 municipalities, resulting in an annual average of 661 kg per household. Significant contrasts occurred between municipalities. Bom Lugar and Satubinha's household averages reached around 1 t per year, while Alto Alegre do Maranhão and Pedreiras' annual averages were respectively limited to 414 and 392 kg. It should be noted that data recorded in this study are restricted to babassu-nuts that are sold, not including production for self-consumption, whether for domestic manufacture of babassu oil or babassu-nut milk, a water-soluble extract (Carneiro et al., 2014).

4.4. Regional traders and processing plants.

The commercialization structure of babassu-nuts is extremely decentralized in its origin, as verified by nearly 640 local traders. All this production is channeled to a relatively restricted number of processing plants, mostly located in the same territory or nearby. This transportation is mainly carried out by a limited number of regional traders who own trucks and travel weekly (or fortnightly) to the villages. Some of these traders sell foodstuff and other goods, supplying the local traders, also known as "*quitandeiros*" or "*bodegueiros*". This relationship, in which the regional trader assumes the role of a local "boss," features strong ties that often go beyond the economic dimension, harking back to the characteristic relationships of the "*aviamento*" system (Aramburu, 1994; McGrath, 2009; Waddington, 2015).

Detailed data obtained from local traders allowed our estimation of the volume of babassu-nuts purchased by each regional trader (Table 4) and transported to crude oil processing industries (Table 5), which are the subsequent links in the value chain. Table 4 lists 23 regional traders with a share of at least 0.5% of the total volume, who are responsible for the transportation of more than 70% of the marketed babassu-nuts. The other 30% are transported directly by processing industries, with no intermediation.

Table 4. Regional traders transporting babassu-nuts (Mearim Valley, 2021)

	Initials	Municipality	Babassu-nuts (t)	% of total	Local suppliers
1	VFJ	Bacabal	517.1	8.6	57
2	MMN	Vitorino Freire	466.6	7.8	58
3	SPE	São Luís Gonzaga do Maranhão	452.9	7.6	39
4	NFC	Bacabal	414.9	6.9	69
5	SCE	Alto Alegre do Maranhão	414.9	6.9	56
6	SMR	Trizidela do Vale	341.3	5.7	49
7	OSJ	Alto Alegre do Maranhão	195.9	3.3	27
8	LMP	Bernardo do Mearim	191.6	3.2	18
9	FC	Lago dos Rodrigues	181.2	3.0	15
10	ABG	Lago da Pedra	115.9	1.9	17
11	SAJ	Lago da Pedra	114.4	1.9	10
12	SLE	Igarapé Grande	111.9	1.9	5
13	BFA	Pedreiras	111.0	1.9	13
14	SNE	Bernardo do Mearim	103.2	1.7	3
15	SDLE	São Luís Gonzaga do Maranhão	74.0	1.2	5
16	GRF	Paulo Ramos	71.7	1.2	5
17	IAR	Alto Alegre do Maranhão	69.0	1.2	15
18	MSM	Lago dos Rodrigues	58.9	1.0	8
19	SGD	Lago do Junco	47.8	0.8	4
20	SDNE	Trizidela do Vale	40.6	0.7	5
21	AAR	Trizidela do Vale	40.4	0.7	3
22	FRJ	Codó	37.0	0.5	4
23	SPF	Coroatá	34.0	0.6	9
	Total		**4,206.4**	**70.0**	**494**

Note: Regional merchants' names are omitted to preserve their anonymity.

Table 5 presents a detailed estimate of the distribution of the volume of babassu-nuts commercialized in 2021 according to the final destination, i.e., processing industries. For a small fraction of this production, babassu-nuts are sold directly to consumers at city markets (10 traders, 0.2% of the volume) and to artisanal babassu oil producers (30 cases, 2.4% of the volume). Almost all the production (97.3%) was channeled to 11 processing plants that press babassu-nuts and produce crude oil, eight of them being in municipalities covered by the research, two in nearby municipalities (Codó and Presidente Dutra), and one in the neighboring state of Piauí. Two other companies are located in the study area but currently do not buy babassu-nuts, opting instead to purchase the crude oil for use in their industrial processes.

Table 5. Final destination of babassu nuts, Mearim Valley, 2021.

	company	municipality	Industry branch			Commercialized volume (t)				purchase sites
			crude oil	soap & sanitizing	refined oil	direct purchase	third party	total	%	
1.	Ioversal	Trizidela do Vale	**X**			138	1,312	**1,450**	24.2	166
2.	Iovesa	Pedreiras	**X**			-	766	**766**	12.8	95
3.	A.C. Leite	Trizidela do Vale	**X**		**X**	243	446	**689**	11.5	71

Table 5. Continued...

	company	municipality	Industry branch			Commercialized volume (t)				purchase sites
			crude oil	soap & sanitizing	refined oil	direct purchase	third party	total	%	
4.	Coppalj	Lago do Junco	**X**		**X**	668	-	**668**	11.1	13
5.	J. S. Oliveira	Alto Alegre do MA	**X**			192	424	**616**	10.3	62
6.	F. C. Oliveira	Codó	**X**	**X**		-	514	**514**	8.6	63
7.	Isomar	Pedreiras	**X**	**X**		-	455	**455**	7.6	72
8.	Nutrilar	Presidente Dutra	**X**	**X**		421	-	**421**	7.0	44
9.	O.G.V. Brasil	Esperantina-PI	**X**		**X**	-	157	**157**	2.6	5
10.	Sabão Lava-Tudo	Bacabal	**X**	**X**		-	62	**62**	1.0	3
11.	ASJB	S. José dos Basílios	**X**			37		**37**	0.6	5
12.	Saponóleo	Trizidela do Vale		**X**			-	**-**		
13.	ÓleosMaia	Trizidela do Vale		**X**			-	**-**		
14.	Artisanal producer of oil (*azeite*)					131	-	**146**	2.4	30
15.	Consumer sale at municipal fairs					13	-	**13**	0.2	10
	Total		**11**	**6**	**3**	**1,843**	**4,136**	**5,995**	**100**	**639**

Unlike the stronger link between local traders and regional merchants, the relationship between the latter and the processing plant is more flexible. Some regional traders sell their production to more than one company, depending on the price charged at the time. Table 5 indicates that of the 11 companies that press babassu-nuts, four produce only crude oil, four others also produce soaps and cleaning products (sanitizers) and three perform the pressing and refining of oil.

4.5. Anatomy of the value chain of babassu-nuts in the Mearim Valley.

The data obtained in the field allowed the schematic representation of the main components of the value chain of babassu nuts and oil. The diagram in Figure 5 presents the commercialization flow from the extraction of nuts by the babassu-nut breakers to the final consumption of the derivative products (traditionally made raw oil, pressed oil, soap and sanitizers, and cosmetics).

Local traders supplied information on the estimated number of extractors, mostly women, selling their production throughout the year. The numbers shown below each component of the diagram indicate the number of households or enterprises identified for each segment of the value chain. The most relevant flow can be seen on the upper axis, where the babassu-nut breakers sell nuts to 585 local traders, who in turn pass them on to 23 regional traders until the production reaches the 11 processing plants that extract crude oil. This oil can be used by 6 companies to make soaps and sanitizers, or, in the case of three other companies, be refined for use in the food industry or as a raw material for cosmetics. The diagram does not represent, however, wholesale and retail companies that market the various products to consumers. The representation of the value chain also excludes the limited role played by suppliers of

basic tools, and the operation of Conab as a key institutional player in the coordination of PGPM-Bio payments, as will be seen in the discussion section. The diagram does highlight the performance of Coppalj, which, in addition to being a critical organizational player, has sought the verticalization of its production, from the reception of nuts in canteens in villages, through its crude oil processing unit, to the recent installation of a refining unit for direct sale to consumers or as raw material for the cosmetic industry. There are also companies, mostly based outside the state of Maranhão and even in other countries, which broker the purchase of babassu oil for cosmetic industries in Brazil and abroad, sometimes even refining the oil as part of this intermediation.

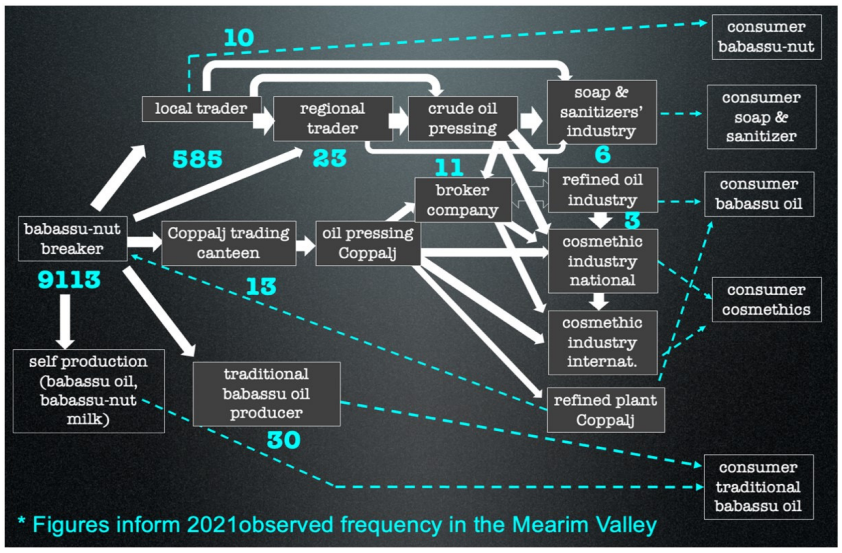

Figure 5. Value chain of babassu-nuts and crude oil, Mearim Valley.

4.6. Policy implications.

Updated and accurate statistics are essential for public policies. Longitudinal field research, such as the study conducted in the Mearim Valley, should contribute to enhancing the positive impact of policies needed to promote the sustainable extraction of NTFPs. This contribution assumes even greater relevance in the contexts of social vulnerability, such as the situation faced by traditional communities engaged in babassu extraction. This study offers insights for the improvement of data collection to generate official statistics on babassu extraction. It also provides guidance for the monitoring of PGPM-Bio, the most relevant public policy for NTFPs in Brazil.

4.6.1. Benchmarking of official data for public policy guidance

Results of this research contribute to providing a standard for data to be released by IBGE, the Brazilian Census Bureau, on production and engagement in extractive activity. Table 6 compares the 2021 commercialization of babassu-nuts at the municipality level verified through the current study, with data recorded in the last two agricultural censuses (2006 and 2017) and estimates available for the last four years of the PEVS series (2017 to 2020).

Results of the present study are quite similar to those recorded in the 2017 Agricultural Census. There is a large discrepancy, however, in relation to PEVS estimates, which report a much higher

volume of babassu-nuts. Analyzing the 2021 aggregated data, the total amount marketed verified in the field survey is equivalent to 27% of the previous year's PEVS estimates, and 77% of the production reported in the 2017 Census. If results of the 2017 Census were projected to 2021 adjusted by the rate of reduction observed in PEVS estimates (12.5% between 2017 and 2020), the volume of babassu-nuts recorded in the field would be equivalent to nearly 90% of this projection.

Table 6. Commercialization of babassu-nuts in Mearim Valley municipalities according to Agricultural Censuses, PEVS and field research.

	t of babassu nuts						
	Agricultural census		PEVS				Field research
Municipality	**2006**	**2017**	**2017**	**2018**	**2019**	**2020**	**2021**
Alto Alegre do Maranhão	57	62	607	534	520	520	129.9
Bacabal	6,087	1,417	2,317	1,900	1,546	1,549	868.7
Bernardo do Mearim	16,523	261	1,148	1,108	1,025	1,017	229.8
Bom Lugar	14,610	634	929	771	748	730	275.5
Capinzal do Norte	112	245	869	848	801	789	79.8
Esperantinópolis	695	342	687	670	627	617	111.4
Igarapé Grande	1,080	22	855	807	763	745	202.8
Joselândia	1,351	169	1,236	1,167	1,068	1050	231.9
Lago da Pedra	1,417	141	1,050	903	881	881	90.5
Lago do Junco	1,243	488	897	863	832	821	637.8
Lago dos Rodrigues	901	111	1,392	1,302	1,230	1,212	250.3
Lima Campos	630	-	354	341	333	327	114.9
Olho D'Água das Cunhãs	126	175	655	557	534	530	140.1
Paulo Ramos	113	170	1,521	1,500	1,390	1,385	267.7
Pedreiras	1,378	63	3,290	3,076	3,276	3,222	50.6
Peritoró	350	153	353	321	289	263	203.6
Pio XII	1,697	220	498	495	480	475	141.5
Poção de Pedras	1,636	834	2,671	2,524	2,360	2,322	216.5
Santo Antônio dos Lopes	2,620	529	948	933	899	884	73.8
São José dos Basílios	801	160	319	315	308	309	52.8
São Luís Gonzaga do Maranhão	1,684	1,065	656	577	576	576	1,018.1
São Roberto	--	48	12	11	11	10	12.1
Satubinha	604	102	486	490	470	460	110.0
Trizidela do Vale	1,967	189	686	674	644	635	201.2
Vitorino Freire	564	282	866	745	725	720	283.9
25 municipalities	**58,246**	**7,834**	**25,290**	**23,421**	**22,325**	**22,039**	**5,995.2**
Brazil	147,865	15,774	54,330	50,804	48,706	47,640	
% of Brazil	39.3%	49.7%	46.5%	46.1%	45.8%	46.2%	

Source: Instituto Brasileiro de Geografia e Estatistica (2006, 2017, 2020).

Discrepancies are even greater at the municipality level. The regional commercial hub of Pedreiras shows 2020 PEVS' estimates for babassu-nuts 51 times greater than what was reported by the 2017 Agricultural Census, and 64 times greater than what was found in the 2021 field survey. This confirms PEVS' bias to allocate production to municipalities where the processing of babassu-nuts takes place.

The engagement of extractivists in the activity can also be gauged from field survey results. Although PEVS' annual estimates do not include extractivists engaged in the activity, it is possible

to project this figure based on data from the Agricultural Census. The available historical series provides an estimated average annual volume of 808 kg of babassu-nuts per landholding.[2] The quotient between annual production and this average value denotes the estimated number of households engaged in the extraction of babassu-nuts.

Methodological procedures that project the current effective engagement in babassu extraction through the integration of data from demographic and agricultural censuses and PEVS estimates were presented elsewhere (Porro, 2022). That publication compares the overall engagement in babassu-nut extraction, including production for consumption, with estimates of households who sell babassu-nuts, data gathered from the present research.

Table 7 summarizes official statistics from IBGE for the total number of rural households, households engaged in the extraction of babassu-nuts, and agricultural landholdings in the 25 municipalities, and compares these databases with field results of the present research. The main conclusions of this analysis are the following:

- The total number of landholdings decreased by 26% between the last two agricultural censuses and corresponds to 45% of the number of rural households projected for 2020.
- The proportion of landholdings engaged in babassu extraction in relation to the total fell from 53% in 2006 to 42% in 2017. In the same period, a 41% reduction is observed in the number of landholdings engaged in this activity.
- The number of households selling babassu-nuts in 2021, identified in the field, is very similar (99%) to the total number of landholdings that reported this activity in the 2017 Agricultural Census.
- The above contingent corresponds to only 33% of the total estimated number of rural households that sold babassu-nuts according to annual productivity projections applied to the PEVS data for the year 2020.
- According to the field research, households selling babassu-nuts in 2021 correspond to 19% of the overall number of rural households and 41% of the landholdings in the municipalities surveyed.

Table 7. Rural households and agricultural landholdings in the Mearim Valley: total and percentage that extract and sell babassu-nuts.

Rural households	Landholdings (Agricultural Census)								Rural households selling babassu nuts	
Projection Demographic Census	Total landholdings		Landholdings informing babassu products						Projection PEVS	Field research
			Nuts	Whole fruit	Nuts+ fruit	Nuts	Whole fruit	Nuts+ fruit		
2020	2006	2017	2006			2017			2020	2021
48,821	29,560	21,957	14,815	717	15,532	5,531	3,601	9,132	27,288	9,113

Source: Instituto Brasileiro de Geografia e Estatistica (2006, 2010, 2017, 2020).

As these 25 municipalities are responsible for more than 45% of the national production of babassu-nuts (Table 6), the reduction in national production in the last 15 years, as well as the decreasing number of extractivists engaged in the activity are likely to be much higher than the trend indicated by the downward curves of the PEVS and will approach the drop registered by the 2017 Agricultural Census.

[2] Considering the historical series of agricultural censuses since 1970, the annual average of babassu-nuts produced per landholding is 808 kg. The 2006 census was excluded from this calculation because possible inaccuracies raised the average of that year to 2,377 kg.

Like municipal estimates of agricultural and livestock production, PEVS data serves the planning of public policies, being accounted for in determining the participation of the agricultural sector in the Gross Domestic Product. Therefore, the analyses presented suggest the need to review procedures adopted to generate PEVS estimates of babassu-nuts, and thus reduce possible distortions derived from incorrect figures influencing these indicators.

4.6.2. Contributions to the monitoring and implementation of PGPM-Bio.

Since 2009, Conab-operated PGPM-Bio has guaranteed minimum prices for 17 NTFPs of Brazil's socio-biodiversity. It pays a bonus to households who can prove sales below a minimum price. Babassu-nut has been the main product addressed by PGPM-Bio since 2015, both in terms of allocated resources (43% of disbursements) and families effectively receiving the subsidy (52%). In recent years, intense mobilization of babassu-nut breakers expanded their access to this policy. Although, from their perspective, PGPM-Bio's subsidy still does not represent a fair value for the labor involved, this income has been critical to the livelihoods of thousands of vulnerable families.

The annual subsidy limit per household varies according to product. In 2021, the maximum amount for babassu-nuts was R$ 3,500 per household, equivalent to US$ 652. Such amount would, on average, subsidize 3,100 kg of babassu-nuts per household, as Conab's minimum price was R$ 3.82/kg (US$ 0.71) while the average annual price identified through field research reached R$ 2.69/kg (US$ 0.50). The annual limit would therefore address the average production of babassu-nut breakers, which, according to the study, reached 661 kg per year.

Babassu-nuts accounted for 42% of the total value of PGPM-Bio subsidies in the last six years (2016-2021) (Companhia Nacional de Abastecimento, 2021). More than 70% of the value and number of subsidized operations related to babassu-nuts took place in the 25 municipalities of the Mearim Valley (Table 8). Correct information about the universe of babassu-nut breakers engaged in the activity and volume produced annually is key for the proper targeting of this policy. Annual budgets are based on proportional goals to be achieved in relation to the total. In addition, the monitoring of the policy's execution must consider target indicators based on official statistics.

Results of the current research show that around 54% of the extractivists who sell babassu in the Mearim Valley sought access to the PGPM-Bio subsidy, a percentage that would be even higher if there had been mobilization in seven municipalities where the subsidy did not occur. The potential impact of this instrument is verified by the rates of households who sought access to PGPM-Bio higher than 80% in five municipalities. Official data indicate, however, that actual access to the subsidy in Mearim Valley municipalities reached 3,488 extraction workers, equivalent to 38% of the total, with the difference (16% of the total) due to non-compliance in processes submitted and not approved for payment (Oliveira et al., 2021).

By analyzing PGPM-Bio's execution reports provided by Conab, it is possible to see that there has not necessarily been a direct correlation between municipalities with higher rates of subsidy and those with higher babassu-nut production or a higher number of extractivists. Some municipalities in Maranhão state that stand out regarding the number of babassu-nut breakers and the volume subsidized by PGPM-Bio, are not well positioned in terms of babassu-nut production, either in the Agricultural Census or according to the PEVS. This may be the result of a greater dominance of local agents who strive to bring the benefits of the policy to their public, which should be evaluated positively. The monitoring instruments can, however, help detect situations that need further investigation. Such a situation occurs when, as seen

in the municipality of Presidente Médici, the total number of babassu-nut breakers benefiting from the subsidy is close to or even higher than the total number of landholdings engaged in babassu extraction, as well as the number of households that sell babassu-nuts based on projections made from PEVS estimates.

Table 8. PGPM-Bio subsidy for babassu nuts (2016–2021).

	PGPM-Bio for babassu nuts: 2016–2021		
	Volume (kg)	Value (R$)	Number of operations
Total	23,673,620	41,240,202	25,501
Mearim Valley: 25 municipalities	17,181,803	29,6276,215	20,499
% of total	72.6%	72.0%	80.4%

Source: Companhia Nacional de Abastecimento (2021).

5. Conclusions

As bioeconomy is presently elevated to a national and even global priority in research, development, and innovation agendas, the babassu-nut is one of the non-timber forest products with the greatest potential for incorporation into programs that promote the sustainable use of Brazil's biodiversity. There are dozens of industrial applications of products derived from the palm (Herrmann et al., 2001; Carrazza et al., 2012; Porro, 2019), the knowledge of which derives substantially from traditional uses by indigenous peoples (Forline, 2000; Nascimento et al., 2009; González-Pérez et al., 2012) and peasant communities. For hundreds of rural communities and tens of thousands of vulnerable families, babassu-nuts are still a relevant source of cash income. Babassu is one of the most abundant palms in the Brazilian Amazon and Cerrado, with a wide distribution that, as early as the 1980s, reached nearly 20 million hectares (Brasil, 1982). With the progression of Amazon deforestation, patterns of forest succession dominated by the babassu palm, which since the early twentieth century were noted in the so-called Brazilian Mid-North, started to be observed in Amazonian expansion fronts and agricultural frontiers, increasing the territorial extent of the palm.

The wide distribution of the babassu palm in high densities and the biological sustainability of the species, which is adapted to forest-succession landscapes, combined with the diversity of products of relevant economic use and substantial production under current conditions contributes to babassu palm's distinctive situation in respect to other extractive species for which domestication is recommended as the main strategy for expanding economic opportunities (Homma, 2018). In addition, the feasibility of integrating babassu palms in landscapes with pastures reconciles the extractive activity with livestock in silvo-pastoral systems, mainly where families are engaged in both activities (Porro & Porro, 2015).

In contrast to this potential, the reality that characterizes babassu's extraction has been progressive discouragement of the activity. Despite the efforts of babassu-nut breakers to expand the reach of PGPM-Bio, the reduction in prices paid for the nut was accentuated in 2019, with direct implications for engagement in the activity. The average price, which throughout 2017 and 2018 oscillated between US$0.50 and US$0.70/kg, fell to less than US$0.30/kg in 2019, mainly due to the largest industrial operators opting for palm oil because of the lower international price of this commodity. Although prices of babassu-oil have partially recovered from the second half of 2020 and throughout 2021 and 2022, difficulties that had already been

affecting the sector in recent decades added to the constant reduction of market opportunities. This makes increasingly uncertain the future of the babassu economy and the livelihoods of families who rely on this NTFP.

The analyses presented in this study highlight the need to review the methodological procedures adopted to generate official data on the extraction of this relevant product to better support public policies directed towards Brazil's socio-biodiversity, and particularly to agro-extractive families that rely on babassu products for their livelihoods. Political decisions are thus urgently needed for institutional changes that stimulate, through pricing and other instruments, greater engagement of families who no longer practice the activity, by enhancing the social and economic benefits of this powerful subsidy offered by nature.

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