forests

MDPI

Article

Innovation Perspectives for the Bioeconomy of Non-Timber Forest Products in Brazil

Sandra Regina Afonso

Brazilian Forest Service, Brasília 70818900, Brazil; sandra.afonso@agro.gov.br or afonsandra@gmail.com

Abstract: Brazil has great potential for the development of an NTFP bioeconomy as it has 500 million hectares of forest. In this article, I seek to identify, through a literature review, innovations in products and processes inserted in the value chain of Brazilian NTFPs with a greater productive value. The hypothesis is that the prospects for the development of the bioeconomy of NTFPs depend on the establishment of a series of innovations along the value chain and in public policies. The production value of NTFPs reached USD 365 million in 2020 and the main NTFPs were açaí, yerba mate, carnaúba pode, Brazil nut, babassu, and pequi. I observed that the products with the highest production value developed innovations in the cultivation of species and in the development of new products. Innovations related to social and commercial organization have been developed within the scope of working in networks. Several policies were implemented based on the construction of a collective concept for the activity related to the NTFPs, sociobiodiversity. Even so, these actions need to be continued and strengthened for the transition to an inclusive, sustainable bioeconomy that takes into account traditional knowledge. Investment in research needs to be constant for the development of new products. Sustainable planting in diversified systems can also be considered an important strategy. Partnerships between the government and the various actors in the value chains are necessary and urgent to ensure innovations, also in the regulatory and organizational environment of NTFPs' value chains.

Keywords: bioeconomy; value chain; non-timber forest products; innovation; new product development

Citation: Afonso, S.R. Innovation Perspectives for the Bioeconomy of Non-Timber Forest Products in Brazil. *Forests* **2022**, *13*, 2046. https://doi.org/10.3390/f13122046

Academic Editor: James L. Chamberlain

Received: 31 August 2022
Accepted: 22 November 2022
Published: 1 December 2022

1. Introduction

A bioeconomy based on forest resources can be defined as a set of economic activities to grow, harvest, process, reuse, recycle, and sell forest products, as well as the associated forest ecosystem services [1,2]. When the concept of a bioeconomy for non-timber forest products is considered, it is highlighted that this activity must take into account the environmental, social, and cultural aspects associated with the use of these resources [1–3]. Piplani and Smith-Hall, 2021; Afonso et al., 2022; and Abramovay et al., 2022 [2–4] also reinforce that the activity can contribute to the reduction of poverty, biodiversity conservation and sustainable consumption.

According to Rodríguez et al. (2019) [5], the regional vision of a bioeconomy in Latin America and the Caribbean can be built on the promotion of sustainable development, climate change mitigation, social inclusion, and innovation processes that contribute to the diversification of the economy.

Brazil, the largest country in Latin America, is also the second-largest country in the world in terms of forest extension, representing about 12% of the world's total forest area, with an estimated 496.6 million hectares of forest (FAO, 2020) [6]. In Brazil, although forests cover 58% of the land area, of which 98% are natural forests, biodiversity is still poorly included in bioeconomy strategies and it requires broadening perspectives regarding what should be included in a bioeconomy.

Some definitions of a bioeconomy also involve the concept of innovation, such as the following: the bioeconomy can be defined as the production, utilization, conservation, and regeneration of biological resources, including related knowledge, science, technology, and innovation, in order to provide sustainable solutions (information, products, processes, and services) within and across all economic sectors, and to enable transformation to a sustainable economy (Global Bioeconomy Summit Communiqué, 2020) [7].

The Oslo Manual 2018 [8], published jointly by the OECD and Eurostat, provides guidelines for collecting and interpreting innovation data. According to the manual, key components of the concept of innovation include the role of knowledge as a basis for innovation, novelty, and utility, as well as value creation or preservation as the presumed goal of innovation.

The requirement for the implementation of innovation differs from other concepts such as invention, as an innovation must be implemented, i.e., put into use or made available for others to use. The general definition of innovation is as follows: "An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or put to use by the unit (process) (Oslo Manual 2018)" [8] (p. 22).

Baregheh et al. (2009) [9] performed an extensive literature review and defined innovation as a multi-stage process through which organizations transform ideas into new/improved products, services, or processes in order to successfully advance, compete, and differentiate in your market.

It is noteworthy, however, that public organizations also seek to innovate to succeed in their scope of action. According to the OECD (2018) [8], managers and stakeholders of private companies and public organizations, academics, and policy users around the world seek to promote innovation because it is a key driver of productivity, economic growth, and well-being. In addition, policies require an empirically grounded understanding of how innovation works to support economic and social changes so that they can address domestic and global challenges. These challenges include changing demographics, the need for food and housing security, climate change and other environmental issues, and many other obstacles to well-being.

In the forestry area, innovation is gaining more and more attention from policymakers and the study of innovation processes has become a refined field of scientific and practice-oriented research [10,11]. Scaling up innovations by strengthening economically sustainable hierarchical producer organizations is imperative for delivering the Sustainable Development Goals and the Paris Agreement on climate change [10].

Non-timber forest products (NTFPs) have a potential in the diversification of forest production in all parts of the world, and they are key to bringing income to local communities [3,4,11–16]. Despite this, NTFPs are not adequately recognized for their contributions to rural livelihoods and the regional economy due to the lack of appropriate policy and governance mechanisms [15].

In this paper, when approaching non-timber forest products (NTFPs), I seek to analyze the value chain because it includes additional elements beyond the coverage of subsector analysis and market analysis. Value chain analysis includes the organizational environment (intercompany cooperation, governance, and public policies) and regulatory environment.

In this sense, innovation in the various processes of the value chain can be fundamental for the development of the bioeconomy of NTFPs. With this in mind, in this article, I seek to identify, through a literature review, innovations in products and processes inserted in the value chain of Brazilian NTFPs with a greater productive value.

2. Materials and Methods

First, I analyzed the value traded in 2020 for the NTFPs and defined the six main products considering the value of commercialization. I used the Brazilian Institute of Geography and Statistics (IBGE, acronym in Portuguese) database, which provides data on NTFPs commercialization value through the System of Aggregated Data (SIDRA, 2020,

acronym in Portuguese) [17]. All 2020 commercialization values were converted to USD using the average exchange rate of 1 USD to 5.1 BRL Brazil Central Bank: "http://www.ipeadata.gov.br/ExibeSerie.aspx?serid=31924 (accessed on 28 March 2022)".

Then, I carried out a review of articles, documents, and official data that dealt with the value chain of each product, looking for aspects of innovation and each part of the chain (production, processing, and commercialization), as well as the public policies in force from 2007 to 2022 (15 years).

Innovations in the various processes of the value chain of the six main products were sought based on a literature review and official data, such as the National Forest Information System (SNIF, acronym in Portuguese) database.

Additionally, the types of innovation identified were classified in accordance with the OECD methodology summarized by Kotsemir et al. (2013) [18] (Table 1).

Table 1. Types of innovation identified were classified in accordance with OECD methodology summarized by Kotsemir et al. (2013).

Type of Innovation	Field of Application
Product innovation	Innovations related to goods and services.
Process innovation	Implementation of new or significantly improved methods of production or delivery of the product.
Marketing innovation	Implementation of new methods of marketing, including significant changes in design or packaging of the product during its storage, market promotion and market-based prices/
Organizational innovation	Implementation of new forms and methods of organization of business companies, the organization of jobs and external relations.

Source: Kotsemir et al. (2013) [18] adaptated from OECD Oslo Manual, third edition (2005).

3. Results

3.1. Main Products

The value of NTFP commercialization reached 365 million USD in 2020 (IBGE, 2021). Considering the commercialization value, the main NTFPs were açaí fruit, yerba mate, carnaúba power, Brazil nut, babassu nut, and pequi fruit (Table 2).

According to a national survey, Brazil generates about 365 hundred million USD a year from the extraction of NTFPs, but only five products are responsible for 90% of this amount. However, this figure is underestimated. Much of what is consumed and sold in the short trade circuits is not accounted for. Additionally, when collecting data only for one product of some species, in some cases, products of great local economic importance are hidden [3,14].

An example of this in the Brazilian savannah is the babassu (*Attalea speciosa* Mart. ex Spreng). Porro (2019) [14] observed that there is underreporting of what is produced by this palm species. This chain is of great importance for the female empowerment of the Interstate Movement of Babassu Coco Breakers.

With functions traditionally performed by the babassu extractivists, the economy includes the local consumption of a wide range of products. Babassu offers opportunities for monetary income, mainly through the sale of kernels [14].

In a study carried out in the Médio Mearim region, where about a third of the national volume of babassu palm kernels are produced, Porro (2019) [14] noted that a wide range of products derived from this palm are ignored by official surveys. In order to fill in this gap, this study examined the economic importance of products derived from the babassu palm in 200 agro-extractive communities in the Mearim River Valley in the state of Maranhão, the main productive region. Projections utilizing a 2017 socioeconomic survey applied in over 1000 households in 18 municipalities in the Mearim Valley indicate that the monetary

value of babassu products in this area alone approached 20 million USD, three times the disclosed value of the kernels.

Table 2. Commercialization value (in thousand dollars) of NTFP production from natural forests in Brazil.

Products	Commercialization Value (in Thousand Dollars)	Percentage	Accumulated Percentage
Açaí palm (fruit)	$136,138.43	37.3%	37.3%
Yerba mate	$109,744.31	30.0%	67.3%
Carnaúba (powder)	$46,116.08	12.6%	80.0%
Amazon nut	$19,323.73	5.3%	85.2%
Babassu (nut)	$17,914.12	4.9%	90.1%
Pequi (fruit)	$8842.35	2.4%	92.6%
Araucaria seed	$8036.08	2.2%	94.8%
Palm heart	$3547.06	1.0%	95.7%
Carnaúba (wax)	$3468.24	0.9%	96.7%
Piassaba	$2420.59	0.7%	97.4%
Umbu (fruit)	$8842.35	2.4%	92.6%
Hevea (gelled latex)	$1302.16	0.4%	98.3%
Cashew nut	$1156.47	0.3%	98.7%
Mangaba (fruit)	$983.73	0.3%	98.9%
Copaiba (oil)	$827.06	0.2%	99.2%
Others	$3071.37	0.8%	100%

Source: the author, based on data from IBGE (2020) [17].

3.2. Value Chain

3.2.1. Production

Looking at the initial phase of the value chain, extraction, or production, it is observed that the two products the most collected annually are açaí and yerba mate. These two products together account for more than 67% of the amount collected. It is noteworthy that such products present innovation in this function of the value chain (production) as they are also cultivated products.

In the case of açaí fruit (*Euterpe oleracea* Mart. and *Euterpe precatoria* Mart.), the National Forest Information System (SNIF, acronym in Portuguese, 2021) indicates that, in 2020, 220 thousand tons of the fruit were extracted and around 1500 thousand tons were cultivated. Compared with natural forests, the production from cultivated areas was about seven times higher in tons. In 2020, the estimated price of the extracted açaí and cultivated açai was around 500 USD per ton.

The açaí production chain has strong traditional characteristics, where the families of collectors are the main consumers. Cialdella and Navegantes-Alves (2014) [19] reported the average consumption of açaí in 2013 in the metropolitan region of Belém, in the Amazon region, at 42.8 kg/inhabitant/year, higher than the consumption of beef (39 kg/inhabitant/year). In addition to the food security provided to riverside dwellers in the Amazon region, it is estimated that more than 500,000 people earn income from harvesting the açaí fruit [19].

According to data from SNIF (2021) [20], the amount of yerba mate (*Ilex paraguariensis* A.St.-Hil.) extracted was 426 thousand tons, in 2020, and 528 thousand tons were cultivated. In 2020, the estimated price of extracted açaí and cultivated açai was around 200 USD per ton.

The yerba mate production chain also has strong traditional characteristics. The dried herb leaves are mainly used to prepare a tea known as chimarrão, although it has the potential to be used as a raw material for soft drinks, sweets, cosmetics, and pharmaceuticals (Oliveira and Waquil, 2015) [21].

3.2.2. Processing

In the processing stage, the second stage in the value chain, many advances were observed in the development of new products, such as açaí, yerba mate, and pequi.

The use of açai as a food is widespread throughout the world, and its pulp is an export product. Additionally, the fruit has been commercialized for pharmaceutical and cosmetic uses. Censi et al. (2018) [22] noted that açai extract is an interesting ingredient for cosmetic antiaging formulations, while Contente et al. (2020) [23] noted that nanoemulsions of acai oil proved to be a good vehicle for imidazole antifungals such as ketoconazole.

The use of pequi (*Caryocar brasiliense* Camb) as a food is traditional and widespread throughout Brazil. However, the fruit has been discovered for its pharmaceutical and nutraceuticals uses. Ombredane et al. (2022) [24] noted that pequi oil extracted from the fruit of a Brazilian native plant contains some molecules with an anticancer potential. They observed promising results as a potential complementary therapeutic approach to be employed along with conventional treatments against breast cancer in the future.

Pequi oil, besides possessing many nutritional properties, may be a good candidate supplement for athletes [25,26]. Vale et al., 2019 [26], noted that supplementation with pequi oil had a protective effect on liver cells against damage caused by oxygen free radicals during strenuous exercise.

As a nutraceutical, pequi pulp oil has been commercialized by the Brazilian industry in the form of capsules; however, Mattos et al. (2021) [27] pointed out the production of pequi nut oil as a product sold in local markets. The roasted pequi almond is also an appreciated and commercialized product; however, it is on a small scale due to the lack of innovation for its extraction.

The full use of the fruit is an important innovation to be sought within the processing activity of the value chain. The study conducted by Porro (2019) [14] showed that the babassu coco is fully used when the oil is extracted from the almond, from the mesocarp the flour, and from the husk the charcoal.

3.2.3. Commercialization

There are also innovations related to the social and commercial organization within the value chain. As an example of this, we have central cooperatives and networks that act in the organization of the chain and promote alliances with Brazilian and foreign companies.

As an example, I can mention the Amazon nut observatory (OCA, acronym in Portuguese), a network of public and private organizations that works to develop the value chain for the Amazon nut (*Bertholletia excelsa* Humn. And Bonpl.), with the goal of improving the living conditions of producing communities and people.

Peerzada et al., 2021 [15], analyzing the bioeconomy of NTFPs in Kashmir, India, observed that fostering public–community partnership by improving the local participation of producers and processors in NTFP value chains for overcoming the existing governance barriers is needed.

The tree species *Bertholletia excelsa* produces the most important nut extracted from the Brazilian natural forests in terms of production value. This food product is highly valued by Amazonian communities as well as the national and international market. According to IBGE, the production of Brazil nuts was more than 33,000 tons in 2020. According to data from SNIF (2021) [28] in the period from 1997 to 2020, approximately 512 million USD were raised with the export of the Amazon nut.

When we approach the commercialization of NTFPs, especially for food exports, as is the case of Amazon nuts, traceability is an important innovation tool. This makes it possible to identify the origin of the product, with information records that allow for the control and monitoring of production activities, which is necessary to guarantee the quality of the products. In this sense, the Origens Brasil® [28] is a network that promotes sustainable business in the Amazon in priority conservation areas, with the guarantee of origin, transparency, traceability of the production chain, and promoting ethical trade for the Amazon nut.

For the commercialization stage of the NTFP value chain, Brazil has been building public policies since 2009. In 2009, the National Plan for the Promotion of Sociobiodiversity Product Chains (PNPSB, acronym in Portuguese) [29] was established. It aimed at strengthening chains and consolidating sustainable markets for non-timber forest products. One of the plan's various actions is the inclusion of sociobiodiversity products in agricultural policies. Among them, the following stand out: policies for the acquisition of these products through public procurement, and subsidies for products sold below production cost and credit lines for the production and processing NTFPs.

3.3. Public Policies

The preparation of PNPSB involved several segments of society working on the subject, and between September 2007 and July 2008, seven regional seminars were organized in the different biomes, with the participation of about 800 people, including representatives of local communities. An additional seminar brought together representatives of the business sector and government representatives, establishing a platform for dialogue to identify limits and point out proposals to advance the consolidation of production chains [29].

The proposals raised in the consultation events were consolidated in a first version of the PNPSB, which was the object of discussion, review, and validation during the "National Seminar on Sociobiodiversity Product Chains: Value Addition and Consolidation of Sustainable Markets", held in Brasília, in July 2008. This event had around 230 participants from different states of the federation, including representatives from traditional peoples and communities and family farmers; government agencies at the federal, state, and and municipal level; companies; and development institutions. The contributions resulting from the National Seminar were incorporated into the final version of the plan [29].

In 2009, PNPSB was established with the general objective of developing integrated actions for the promotion and strengthening of sociobiodiversity product chains. The products of sociobiodiversity were thus defined as follows:

> "Goods and services (final 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 valorization of their practices and knowledge, and ensure the resulting rights, generating income and promoting the improvement of their quality of life and the environment in which they live (BRASIL, 2009)" [29].

The PNPSB presented actions focused on six axes: (i) promotion and support for sustainable production and extractivism, (ii) structuring and strengthening of the industrial processes, (iii) structuring and strengthening markets for sociobiodiversity products, (iv) strengthening of social and productive organization, (v) complementary actions to strengthen sociobiodiversity product chains, and (vi) complementary actions for the valuation of sociobiodiversity services [29].

PNPSB is innovative by proposing its action at three levels: (i) macro—institutionalizing policies and regulations; (ii) meso—offering technical assistance and training services and promoting market and technological research; (iii) micro—promoting the development of production chains and consolidation of markets [29].

Among the macro-level actions was the establishment of public policy programs. Two of them can be highlighted, namely the Food Acquisition Program (PAA, acronym in Portuguese) and the Minimum Price Guarantee Policy for Sociobiodiversity Products (PGPM-Bio, acronym in Portuguese) [29].

PAA was instituted to encourage the purchase of local products for consumption by public institutions, such as schools and hospitals, among others. In this way, it stimulated the purchase of products from small producers and products from sociobiodiversity. The acquisition prices were based on the values established in the market and, at a minimum, the values determined by PGPM-Bio. Additionally, the PGPM-Bio allowed for a subsidy for producers who sell their products below production cost.

At a meso level, partner actions, among the ministries involved in the plan, are developed in order to offer specific technical assistance and training for extractive production within the scope of the Productive Inclusion of the Bolsa Verde Program, reaching 22,000 families living in forested areas.

At the micro level, the National Plan for the PNPSB acted, on a national basis, in the Brazil nut and babassu chains, which together involve 500,000 families and generate 160 million/year.

Other chains are supported on a territorial basis in the strengthening of local productive arrangements. In this way, PNPSB supported the organization of its production chains in strategic locations for the occurrence, production, and commercialization of products. The management of PNPSB took place through governance bodies involving states and civil society, with the national coordination of the plan—with operational and deliberative attributions and the National and State Chambers and the Local Productive Arrangements.

Finally, it is important to mention that ten NTFP chains were supported under this plan: Açaí, Carnaúba, Amazon nut, Babassu, Pequi, Piassaba, Hevea, Buriti, Copaiba, and Andiroba. The support strategy started from the analysis of the value chain of each product together with the actors in the chain. After that, the future vision for the value chain and an action plan were defined.

In addition to these policies and programs, in 2019, with the diffusion of the bioeconomy concept in the world, Brazil incorporated the term and created the Brazilian Bioeconomy Sociobiodiversity Program [30].

The program aimed at increasing the participation of small farmers, family farmers, traditional peoples, and communities and their productive arrangements that involve the concept of the bioeconomy. However, the program does not bring the concept of the bioeconomy, it only incorporates the term together with the much-discussed term sociobiodiversity.

The program's objective is to promote the partnership between public and private sectors, aiming at the promotion and structuring of production systems based on the sustainable use of sociobiodiversity resources with a focus on generating income and improving the quality of life of the public involved [31].

The program maintains policies that contribute to the commercialization of products, PAA and PGPM-Bio. Thousands of tons of food from sociobiodiversity, whether processed or not, were acquired over 15 years. Currently, more than 80 products characterized as sociobiodiversity can be purchased institutionally. This also brought about an appreciation of Brazilian biodiversity and its uses [31].

In addition to these policies, initiatives were established to differentiate production through distinctive signs, such as the National Seal of Family Agriculture and Geographical Identifications. These seals make it possible to inform the consumer public of the non-monetary values associated with sociobiodiversity products from family farming and traditional peoples and communities.

Finally, it is important to mention the Biodiversity Law (Law 13.123/2015) [32], which regulates access to genetic heritage, access to associated traditional knowledge, and the sharing of benefits for the conservation and sustainable use of biodiversity. This law is an important instrument that allows holders of traditional knowledge associated with the use of biodiversity to receive financial resources through funds. These funds are managed by community organizations, such as the Iratapuru Fund [33], established by a cooperative to receive benefits from the sale of Amazon nuts to a cosmetic company.

3.4. Types of Innovation Identified

Finally, the innovations identified in the part of the chain were classified by type of innovation (Table 3).

Table 3. Innovations identified by type of innovation.

Type of Innovation	Part of the Chain	Innovation Identified
Product innovation	Processing	Research published in the last 5 years: Açaí processing for export; açai fruit for pharmaceutical and cosmetic uses. Açai extract as an ingredient for cosmetic antiaging formulations; nanoemulsions of acai oil proved to be a good vehicle for imidazole antifungals such as ketoconazole. Pequi for pharmaceutical and nutraceuticals uses. Pequi oil contains some molecules with an anticancer potential. Pequi oil, besides possessing many nutritional properties, may be a good candidate supplement for athletes. As a nutraceutical, pequi pulp oil has been commercialized by the Brazilian industry in the form of capsules. Babassu coco has been fully used when the oil is extracted from the almond, from the mesocarp the flour and from the husk the charcoal.
Process innovation	Production	Açaí and yerba mate cultivation.
Marketing innovation	Commercialization	Origens Brasil® promotes sustainable business in the Amazon in priority conservation areas, with a guarantee of origin, transparency, traceability of the production chain and promoting ethical trade for the Amazon nut. National Plan for the Promotion of Sociobiodiversity Product Chains (PNPSB, acronym in Portuguese) aimed at strengthening chains and consolidating sustainable markets for non-timber forest products.
Organizational innovation	Commercialization	Central Cooperatives and networks that act in the organization of the chain and promote alliances with Brazilian and foreign companies. Ex. Amazon nut observatory (OCA).

4. Discussion

Statistics on NTFPs are, in general, a challenge for different countries. Estimates of trade at local, regional, and global levels are underestimated as NTFP are traded mostly in informal markets. This has resulted in poor representation in national and international statistics [15,34].

According to report The State of the World's Forests 2022, some NTFPs are driving multimillion and even multibillion-dollar industries associated with cosmetics, food, and health and well-being, but may be invisible in national accounts because they are in categories encompassing both collected and cultivated volumes [34].

FAOSTAT81 reports the production and trade for the Brazil nut, which grows across the Amazon Basin and is harvested in the wild mainly in three countries: Bolivia (Plurinational State of), Brazil, and Peru. The export value of Brazil nuts amounted to 373 million USD globally in 2019, data underestimated by exporting countries. Data on the production and trade of shea nuts (used to produce shea butter) produced from *Vitellaria paradoxa*, a species with a wide range stretching from Senegal to Uganda. It is assumed that the most of the shea nuts used to make shea butter are collected in the wild. Six West African countries reported a total of 14 million tons of shea nut exports in 2007–2017, but the actual volume of trade may be higher because internationally traded medicinal plant species are collected from the wild [34].

For Brazil, it is no different; there is an underestimation of the quantity produced because consumption and short sales circuits are not accounted for [3]. In addition, the diversity of

products makes counting difficult. In less structured chains, such as babassu, this is evident. Innovations regarding these estimates using digital tools need to be developed [34].

When we look at the functions of the value chain of the products studied, it is observed that the two products with the highest collection value developed innovations regarding the cultivation of species for commercialization purposes, overcoming the barriers of extractivism. This could be an important innovation especially if they are not monocultures but diversified crops.

In Europe, agroforestry systems are more common, resulting in highly productive areas including cereals, trees, and animal productions combining high biodiversity and good ecosystem services. Aumeeruddy-Thomas et al., 2012 [13], studied rural chestnut (*Castanea sativa*) and truffled holm oak (*Quercus ilex* L.) forests, and concluded that the socio-ecological legacies that comprise domestication at different scales and innovations linked to change in society have contributed to its resilience. In modern contexts, rural forests are good models for reflections on the importance of domestication processes as part of socio-ecological legacies. These two rural forests are very similar to many highly productive systems developed by rural societies, such as the Dehesa in Spain, the Montados in Portugal, and many similar systems found throughout the Mediterranean basin.

Innovations related to the social and commercial organization within the value chain have been developed within the scope of acting in networks. The Amazon nut is a prominent product in this sense, which has been establishing a series of networks and partnerships to improve production, management, and marketing. In this sense, Nybakk et al., 2009 [35], studied Norwegian forests and the results showed that social networking and a learning orientation positively impact innovativeness, which in turn improve the economic performance of Norwegian forestland owners.

With regard to commercialization, several programs and policies have been implemented based on a movement to strengthen the agenda in 2007, when the discussion on PNPSB began. It is noteworthy that this plan innovated by building a concept collectively for the activity related to NTFPs, sociobiodiversity. This was an important innovation for our internal communication in the country.

PNPSB also innovates by bringing different policies to support agriculture for the harvesting of NTFPs, by building different instances of participation and management and by proposing a joint construction of actions focused on value chains. According Velde et al. (2005) [12], value chain analysis is a methodology that is different from other market chain analysis methodologies such as the chain analysis advanced by Porter. Innovation by actors in the market for NTFPs cannot be fully understood without an adequate understanding of the position and behavior of actors in the NTFPs value chain.

Finally, when observing the policies established for the promote NTFPs bioeconomy in Brazil, it is noted that there are a series of innovations and advances brought by the PNPSB, especially the commercialization of NTFPs. These actions must be continued and expanded so that there is a transition to the bioeconomy.

According Peerzada et al., 2022 [16], to realize the full potential of NTFPs, it is important that they are marketed as a diversified product through a bioeconomy that ensures the sustainable use of wild species, following sustainable livelihoods, income generation, and inclusive development. In this sense, the government can play an important supporting role where markets do not function in an inclusive way. An inclusive economy includes resources that lack sufficient markets to manage supply and demand, and addresses the issues of undersupply, miscommunication, and overexploitation. Progressive management of forest resources and trade policies must be interactive in nature and must recognize local rights, knowledge, and practices to ensure access and concessions for sustainable harvesting of NTFPs for socio-ecological and economic well-being.

5. Conclusions

The article examined the types of innovations over the value chains of Brazilian NTFPs. This analysis showed that there were some innovations established in recent years, and, specifically, in the period of establishment of the PNSB, there were many actions that focus on value chains that were undertaken by the government in partnership with society.

Even so, these actions need to be continued and strengthened so that the transition to an inclusive, sustainable bioeconomy that takes into account traditional knowledge takes place. Investment in research needs to be constant for the development of new products. Sustainable planting in diversified systems can also be considered an important strategy. Partnerships between the government and the various actors in the value chains are necessary and urgent to ensure innovations also in the regulatory and organizational environment of NTFPs' value chains.

Funding: This research received no external funding.

Institutional Review Board Statement: "Not applicable" as the study that does not involve humans or animals.

Data Availability Statement: Data on the quantity of NTFPs produced in Brazil can be found on the following platforms: https://sidra.ibge.gov.br/pesquisa/pevs/quadros/brasil/2021 (accessed on 10 January 2021) and https://snif.florestal.gov.br/pt-br/producao (accessed on 10 January 2021).

Conflicts of Interest: The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Afonso, S.R. Produtos florestais não madeireiros: Do extrativismo vegetal à bioeconomia da floresta. In *Produtos Florestais Não Madeireiros: Tecnologia, Mercado, Pesquisas e Atualidades*; Evangelista, W.V., Ed.; Científica Digital: Guarujá, Brazil, 2021; pp. 29–43.
2. Piplani, M.; Smith-Hall, C. Towards a Global Framework for Analysing the Forest-Based Bioeconomy. *Forests* **2021**, *12*, 1673. [CrossRef]
3. Afonso, S.R.; Freitas, J.V.; Diniz, J.D.A.S.; Lima, M.F.B. The potential for using non-timber forest products to develop the Brazilian bioeconomy. In *The Bioeconomy and Non-Timber Forest Products*; Smith-Hall, C., Chamberlain, J., Eds.; Routledge: London, UK, 2022; 232p. (in press)
4. Abramovay, R.; Ferreira, J.; Costa, F.A.; Ehrlich, M.; Euler AM, C.; Young, C.E.F.; Kaimowitz, D.; Moutinho, P.; Nobre, I.; Rogez, H.; et al. (Eds.) *Amazon Assessment Report 2021*; United Nations Sustainable Development Solutions Network: New York, NY, USA, 2021. [CrossRef]
5. Rodríguez, A.G.; Rodrigues, M.; Sotomayor, O. Towards a sustainable bioeconomy in Latin America and the Caribbean: Elements for a regional vision. In *Natural Resources and Development Series*; Economic Commission for Latin America and the Caribbean (ECLAC) 2019 n°193 (LC/TS.2019/25 Santiago, Economic Commission for Latin America and the Caribbean (ECLAC): Santiago, Chile, 2019. Available online: https://repositorio.cepal.org/bitstream/handle/11362/44994/1/S1901014_en.pdf (accessed on 21 December 2021).
6. FAO. *Global Forest Resources Assessment 2020: Main Report*; FAO: Rome, Italy, 2020.
7. FAO. *Aspirational Principles and Criteria for a Sustainable Bioeconomy*; FAO: Rome, Italy, 2021. Available online: https://www.fao.org/3/cb3706en/cb3706en.pdf (accessed on 21 December 2021).
8. OECD/Eurostat. *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation*, 4th ed.; The Measurement of Scientific, Technological and Innovation Activities; OECD Publishing: Paris, France; Eurostat: Luxembourg, 2018. [CrossRef]
9. Baregheh, A.; Rowley, J.; Sambrook, S. Towards a multidisciplinar definition of innovation. *Manag. Decis.* **2009**, *47*, 1323–1339. [CrossRef]
10. Macquen, D.; Bolin, A.; Greijmans, M.; Grouwels, S.; Humphries, S. Innovations towards prosperity emerging in locally controlled forest business models and prospects for scaling up. *World Dev.* **2018**, *125*, 104382. [CrossRef]
11. Weiss, G.; Ludvig, A.; Živojinović, I. Four decades of innovation research in forestry and the forest-based industries—A systematic literature review. *For. Policy Econ.* **2020**, *120*, 102288. [CrossRef]
12. Velde, D.W.; Rushton, J.; Schreckenberg, K.; Marshall, E.; Edouard, F.; Newton, A.; Arancibia, E. Intrepreneurship in value chains of non-timber forest products. *For. Policy Econ.* **2006**, *8*, 725–741. [CrossRef]
13. Aumeeruddy-Thomas, Y.; Therville, C. Resilience of Sweet Chestnut and Truffle Holm-Oak Rural Forests in Languedoc-Roussillon, France: Roles of Social-Ecological Legacies, Domestication, and Innovations. *Ecol. Soc.* **2012**, *17*, 2. [CrossRef]
14. Porro, R. A economia invisível do babaçu e sua importância para meios de vida em comunidades agroextrativistas. Boletim do Museu Paraense Emílio Goeldi. *Ciências Hum.* **2019**, *14*, 169–188.

15. Peerzada, I.A.; Chamberlain, J.; Reddy, M.; Dhyani, S.; Saha, S. Policy and Governance Implications for Transition to NTFP-Based Bioeconomy in Kashmir Himalayas. *Sustainability* **2021**, *13*, 11811. [CrossRef]
16. Peerzada, I.A.; Islam, M.A.; Chamberlain, J.; Dhyani, S.; Reddy, M.; Saha, S. Potential of NTFP Based Bioeconomy in Livelihood Security and Income Inequality Mitigation in Kashmir Himalayas. *Sustainability* **2022**, *14*, 2281. [CrossRef]
17. Instituto Brasileiro de Geografia e Estatística. Available online: https://sidra.ibge.gov.br/ (accessed on 10 January 2021).
18. Kotsemir, M.; Abroskin, A.; Dirk, M. Innovation Concepts and Typology—An Evolutionary discussion. Basic research Program Working Papers. In *MPRA Paper No. 46667*; Series: Science, Techonology and Innovation; MPRA: Munich, Germany, 2013. Available online: https://mpra.ub.uni-muenchen.de/46667/ (accessed on 10 January 2021).
19. Cialdella, N.; Navegantes-Alves, L. La ruée vers l'açaii (*Euterpe oleracea* Mart.): Trajectoires d'un fruit emblématique d'Amazonie. *Tiers Monde* **2014**, *220*, 119–135. [CrossRef]
20. SNIF (Sistema Nacional de Informações Florestais). Boletim SNIF 2021. Available online: https://snif.florestal.gov.br/images/pdf/publicacoes/periodo_eleitoral/Boletim_SNIF_2021_periodo_eleitoral.pdf (accessed on 30 June 2022).
21. Oliveira, S.V.; Waquil, P.D. Dinâmica de produção e comercialização da erva-mate no Rio Grande do Sul, Brasil. *Ciência Rural* **2015**, *45*, 750–756. [CrossRef]
22. Censi, R.; Peregrina, D.V.; Lacava, G.; Agas, D.; Lupidi, G.; Sabbieti, M.G.; Di Martino, P. Cosmetic Formulation Based on an Açai Extract. *Cosmetics* **2018**, *5*, 48. [CrossRef]
23. Contente, D.M.L.; Pereira, R.R.; Rodrigues, A.M.C.; Silva, E.O.; Ribeiro-Costa, R.M.; Sila-Júnior, J.O.C. Nanoemulsions of Acai Oil: Physicochemical Characterization for the Topical Delivery of Antifungal Drugs. *Chem. Eng. Technol.* **2020**, *43*, 1424–1432. [CrossRef]
24. Ombredane, A.S.; Silva, L.R.A.; Araújo, V.H.S.; Costa, L.P.; Silva, L.C.; Sampaio, M.C.; Lima, M.C.F.M.; Veiga Junior, V.F.; Vieira, I.J.C.; Azevedo, R.B.; et al. Pequi oil (*Caryocar brasilense* Cambess.) nanoemulsion alters cell proliferation and damages key organelles in triple-negative breast câncer cells in vitro. *Biomed. Pharmacother.* **2022**, *153*, 113348. [CrossRef] [PubMed]
25. Miranda-Vilela, A.L.; Pereira, C.S.; Gonçalves, C.A.; Grisolia, C.K. Pequi fruit (*Caryocar brasiliense* Camb.) pulp oil reduces exercise-induced inflammatory markers and blood pressure of male and female runners. *Nutr. Res.* **2009**, *29*, 850–858. [CrossRef] [PubMed]
26. Vale, A.F.; Ferreira, H.H.; Benetti, E.J.; Rebelo, A.C.S.; Figueiredo, A.C.R.; Brabosa, E.C.; Simões, K. Antioxidant effect of the pequi oil (*Caryocar brasiliense*) on the hepatic tissue of rats trained by exhaustive swimming exercises. *Braz. J. Biol.* **2019**, *79*, 257–262. [CrossRef] [PubMed]
27. Mattos, L.M.; Afonso, S.R.; Lima, M.F.B.; Almeida, R.; Chiles, J.M.; Favaro, S.P.; Moreira, A.C.O.; Malaquias, J.V.; Sevilha, A.C. Caracterização e Análise Financeira do Processo de Extração de Óleo de Polpa de Pequi no Cerrado Brasileiro. *Bol. Pesqui. Desenvolv. (Embrapa Cerrados)* **2021**, *377*, 64.
28. Available online: https://www.origensbrasil.org.br/ (accessed on 30 June 2022).
29. BRASIL. Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade. Brasília, Julho de 2009. Available online: https://bibliotecadigital.economia.gov.br/bitstream/123456789/1024/1/Plano%20Sociobiodiversidade.pdf (accessed on 30 June 2022).
30. Portaria nº 121, de 18 de Junho de 2019— Institui o Programa Bioeconomia Brasil—Sociobiodiversidade, Definindo Objetivos e Eixos Temáticos. Available online: https://www.in.gov.br/web/dou/-/portaria-n-121-de-18-de-junho-de-2019-164325642 (accessed on 30 June 2022).
31. BRASIL. Bioeconomia da Floresta: A Conjuntura da Produção Não Madeireira no Brasil 2009. Available online: http://www.planalto.gov.br/CCIVIL_03/_Ato2015-2018/2015/Lei/L13123.html (accessed on 30 June 2022).
32. Lei da Biodiversidade 2015. Available online: http://www.planalto.gov.br/CCIVIL_03/_Ato2015-2018/2015/Lei/L13123.htm (accessed on 30 June 2022).
33. Fundo Iratapuru. Available online: https://www.fundoiratapuru.com/quem-somos (accessed on 30 June 2022).
34. FAO; UNEP. *The State of the World's Forests 2020. Forests, Biodiversity and People*; FAO: Rome, Italy, 2020. [CrossRef]
35. Nybakk, E.; Lawrence, A.; Weiss, G. Innovation in Forest Management for New Forest Owner Types—A Literature Review. In: Background Paper of Working Group 2."New Forest Management Approaches", COST Action FP1201 "Forest Land Ownership Changes in Europe: Significance for Management and Policy". 2015. Available online: https://www.researchgate.net/publication/303823188 (accessed on 10 October 2022).