ABSTRACT

VUOLA, MATLEENA MAIJA. Regional Markets for Non-timber Forest Products in Eastern Brazilian Amazon. (Under the direction of committee with chair Erin Sills).

While export of non-timber forest products (NTFPs) has been promoted as a sustainable development strategy, the literature suggests that local and regional markets are also potentially important, not only for producers but also for traders and consumers (Shackleton et al. 2007). For producers, regional markets are thought to offer more accessible and more stable markets, while for traders, these markets offer employment, and for consumers, reasonably priced, diverse, fresh food.

Consumption habits are changing in developing countries primarily due to urbanization and commercialized food systems as described by Johns and Maundu (2006). One result is the so-called "nutrition transition," in which people adopt diets that are higher in energy (more added sugar and fat) but have less nutritional quality (Popkin, 2004). In this context, Johns and Sthapit (2004) argue that it should be a policy priority to promote a diverse diet including a lot of indigenous foods (fruits, vegetables and whole grain products) and a proper amount of animal products. In addition to their potential dietary contributions, forests also offer a diversity of traditional medicinal plants. Many people rely on these plants as a health care option because they are cheap, efficient and have cultural meaning. Medicinal plants are important for both the rural and urban poor in the Brazilian Amazon where the healthcare system is weak and unemployment is increasing (Shanley & Luz, 2003).

In this thesis, I characterize the market for NTFPs in a major regional market in the Brazilian Amazon (the city of Belém), drawing on a survey of consumers in 2006 through 2009 (overall sample n=2635 consumers) that focused on seven popular NTFPs native to the area: açai palm fruit, medicinal oils (andiroba and copaiba), fruits (piquía, uxí, bacuri), and Brazil nut. In the first section, I describe who is buying NTFPs and identify trends in consumption across the four years of the survey. In the second section, I develop a market segmentation analysis, identifying, characterizing, and describing trends among different types of NTFP consumers. The market segments are identified based on two-step cluster analysis in SPSS.

The results confirm that people in Belém use a wide variety of NTFPs, with fruits being the most commonly consumed. The seven focal NTFPs were popular during the study period, with over 95% of respondents (in each of the three years of the study when this was asked directly) reporting use of at least one of these products. However, the people who use NTFPs are not necessarily aware that they are consuming products from the native forest: according to the cluster analysis, half of the consumers fall into market segments that either do not consider themselves as NTFP consumers or are not aware that they consume NTFPs. These segments are comprised of people with less education and lower income, more females, and more long-term urban residents including natives of Belém. The other consumer segments, characterized by higher income and education and more recent migration to Belém, have greater awareness of NTFPs. If these segments grow, that could imply growth in demand for forest products. However, over the four years of the study, there was actually a decreasing trend in consumption of NTFPs, indicated by declining average counts of NTFPs and declining proportions of respondents who consume the focal products. This could be due to increasing prices, also observed in the data, which in turn may be due to the on-going forest degradation that is well-documented in the literature on the Brazilian Amazon.

Regional Markets for Non-timber Forest Products
in Eastern Brazilian Amazon

by
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DEDICATION

I dedicate my work to my dear husband Aaron, who has been incredible patient during my thesis process. He has spent almost a year taking care of our son Elmo. Thank you for giving me the time to study and for cooking delicious food!

BIOGRAPHY

Matleena Vuola was born on July 19, 1986 in Nurmijärvi, Finland to parents Esko and Terhi Väisänen. The youngest of three daughters, she has two older sisters, Milja and Annaliina. Matleena crew up spending time with her friends and doing some sports including soccer, basketball and athletics. Matleena spent an exchange year in Ecuador when she was in high school (at the age of 17) and became interested in environmental and development issues. She was interested in economics as well and wanted to combine these areas in in her studies. This led her to study forest products marketing in 2006 at University of Helsinki. This is where she met her future husband. During her Bachelor studies Matleena spent one semester in Universidad de Costa Rica together with her husband Aaron and did plantation forestry field course in Uruguay. Matleena and Aaron had a son, Elmo, in spring 2011 in Sweden while Aaron was studying. In 2011, she attended the Master's program called Atlantis and this has led the whole family to travel quite a bit. The academic year 2011-2012 she spent in Raleigh, North Carolina studying at North Carolina State University. Fall 2012, Matleena studied in Alnarp, Sweden. She is hoping to work with environmental (maybe NTFPs) and development issues possibly in Latin America.

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Introduction

Non-timber forest products (NTFPs), harvested from the native Amazon rainforest have attracted the attention of researchers, environmental organizations, and groups promoting sustainable development at least since the late 1980s (Sills et al., 2011). Most of the focus has been on traditional systems for managing, harvesting, and marketing these products, and the potential to create a profit incentive for forest conservation through improved marketing that achieves higher prices (e.g. in international green markets) and delivers a larger portion of that price to the collector living in the forest (e.g. through "fair trade"). Local and regional markets for NTFPs have received much less attention (Shackleton et al., 2007) although several authors have highlighted their potential for delivering the sustainable development and conservation benefits that many have sought from NTFPs.

In this thesis, I characterize the market for NTFPs in a major regional in the Brazilian Amazon (the city of Belém), drawing on a survey of consumers in 2006 through 2009. I have two wide research objectives:

1. The first of these is to characterize the market for NTFPs in Belém, describing general trends over the four years of the surveys with respect to who is consuming NTFPs and what products are being purchased, where, and at what prices.
2. The second aim is to create a typology of consumers based on market segmentation with cluster analysis.

Before turning to these results, I first review the relevant literature, describe the study site and the NTFPs of interest, and explain how the data were collected.

Literature review

The literature on NTFPs, and especially their potential role in poverty alleviation, has swung between optimism and pessimism since they started attracting more attention in the late 1980s. Today, forests (including NTFPs) are considered more likely to serve as "safety nets," offering poor people subsistence and cash income during difficult times, than a ladder out of poverty (Shackleton et al., 2011). The "safety net" role of NTFPs may become increasingly important in the future for low-income households facing the effects of climate change (Sills et al. 2011).

The importance of regional/local markets for non-timber forest products

Most studies of the commercialization of NTFPs focus on export markets rather than domestic markets. Regional or local markets near the forests where NTFPs are harvested are practically "invisible" to governments, largely because they are informal. Lack of research on these markets is both due to and contributes to this "invisibility." However, regional markets often absorb a large portion of production, and they are important for many local people who either work or shop in these markets. Just as in rural areas, many people in market centers depend on NTFPs either as a part of their diet or as a source of income (Shackleton et al., 2007). Of the limited research that has been done on regional markets, most concentrate on the producers and sellers of NTFPs, rather than the consumers. The few exceptions rely on very small samples of consumers (e.g., Mukul (2011) interviewed only 12 consumers). In this literature review, I first summarize arguments that have been made for the importance of local and regional markets for NTFPs, then challenges that have been identified with commercialization of NTFPs, and finally methods and findings from previous studies of regional markets for NTFPs in developing countries and for horticultural products in Brazil.

Shackleton et al. (2007) argue that local markets for NTFPs are important especially for poor people. In the table reproduced below (Table 1), they summarize the special characteristics of NTFP markets and compare local to international markets, based on the research of Dove (1993), Dewees and Scherr (1996), Taylor (1999), Arnold (2002), Philips (2002), Institute of Natural Resource (2003) and Schreckenberg (2003). They contend that local markets are easier for producers to access, as they are oftentimes informal, less technological and capital investment is needed, and there are fewer intermediaries involved than in international markets. They also suggest that local markets are more stable than international markets, partly due to the cultural value of many products that ensures stable demand. This is relevant to the case study considered in this thesis, as the Brazilian Amazon is rapidly urbanizing (e.g., 69% of the population of Pará is urban), and other researchers have found that many Amazonian people retain rural consumption habits after migrating to cities (Padoch et al., 2008). This might mean increasing demand for some non-timber forest products as the purchasing power of rural to urban migrants increases; for example, Padoch et al. (2008) report increased demand for açai in the Amazon estuary and for cheap construction materials in the Peruvian Amazon (Padoch et al., 2008). They conclude that even though recent immigrants might be poor, they still have important effects on urban markets (Padoch et al., 2008). According to Ndoye et al. (1998) a new type of consumer is created in urban NTFP markets as recent migrants to cities no longer have opportunities to collect NTFPs and therefore must purchase if they want to consume them. Ndoye et al. (1998) also note that peri-urban markets not only provide NTFPs for consumers, but also offer a lot of employment for the vendors (and processors) of NTFPs. Taken together, these characteristics of local markets could increase the value of forest for NTFP production.

Table 1. Advantages and disadvantages of local markets (Based on the research of Dove (1993), Dewees and Scherr (1996), Taylor (1999), Arnold (2002), Philips (2002), Institute of Natural Resource (2003) and Schreckenberg (2003))

Advantages of local markets	Disadvantages of local markets
Existence value: Local markets exist, and may be relatively large, while export markets often have to be developed.	**Limited growth:** Local markets may show limited potential for growth or grow more slowly than export markets, but this does not apply to all products.
Stable: Local markets are relatively stable and guaranteed while export markets are often fickle, uncertain and demonstrate 'boom and bust' characteristics.	**Saturation:** Local markets can quickly become saturated, limiting opportunities for new entrants, impacting on incomes and constraining expansion of individual businesses.
Self-reliance: Participants in local markets are often independent, whereas various dependencies are created for export markets increasing the risk of benefit capture away from local beneficiaries and collapse if any of the actors withdraw.	**Neglected and invisible:** Local markets have poor external visibility and are often neglected by policy makers and development planners receiving little support.
Low technological requirements: Low-cost appropriate technology is often adequate for local markets, whereas sophisticated export markets may require a very different level of processing, quality control and grading.	**Low research investment:** Local markets and products lack research and development (e.g. extending shelf life, resource ecology and management) relative to emerging internationally marketed products.
Fewer regulations: Local markets are relatively unregulated with less bureaucracy as compared to the complex regulations for exported products.	**Lack of support:** Producers often lack the technology, credit, contacts or skills to develop their businesses and have little access to external support.
Lower risk of appropriation: Because of the lower value of goods sold in local markets there is less risk of takeover by elites or displacement by large-scale cultivated sources.	**Deficit of information and sales options:** Rural areas may have scant access to market intelligence and may be beholden to historical trade patterns.
Low barriers to entry: Local markets have low barriers to entry compared to export markets allowing poor, unskilled and marginalised community members to engage in the trade.	**Less opportunity for diversification:** Local markets may show less potential for product diversification to reduce risk in the long-term (due to technology constraints for example), whereas this is often a feature that is developed for export markets.
Low investment: Minimal intervention and capital investment is required to support local trade and enhance livelihood benefits.	**Marginalisation:** Informal traders may face problems establishing themselves in the market place and frequently encounter harassment. The conditions under which they operate are often poor.
Cultural value: The cultural value of many locally traded products provides market stability and can be used to expand markets amongst urban communities with strong rural roots. Many of the products having value in local markets may be have limited potential in export markets.	**Time consuming supply chain:** Producers supplying local markets may be constrained by performing all or most functions along the trade chain. At the same time, however, such horizontal integration could be seen has having positive benefits including more control, realisation of more benefits, less dependency, etc.
Economies of scale: The economies of scale of local markets can be appropriate in remote areas where some products are more effectively supplied locally.	**Geographically dispersed:** Producers supplying local markets are often dispersed over large areas making it difficult to target interventions and build collaboration.
Control and flexibility: In local markets, participants may have greater control, setting their own prices, selling where and to whom they wish, and determining their own work pace to fit in with other household activities.	**Low purchasing power:** Consumers located near local markets are often poor and have limited buying power keeping prices low. Products in specialised export markets can often fetch high prices.
Local knowledge of markets: Local producers and traders understand the needs of local markets, the quality standards and expectations. Export markets tend to be socially and geographically foreign.	**Lack of consumers for new goods:** There may be few buyers in local markets for producers who are creative and produce high quality, unusual goods.
Accessible: Local markets are accessible and close to producers/ traders reducing transaction costs relative to export markets.	**Isolated:** Local markets are often located in marginalised areas characterised by poorly developed transport and communication infrastructure.

Non-timber forest products are important for urban and rural consumers in developing countries. One reason is the diversity of NTFPs, including many fruits and vegetables. Johns and Maundu (2006) describe changing consumption habits in developing countries, primarily due to urbanization and commercialized food systems. The main concerns related to the changing consumption habits are that diets become less diverse as well as nutritionally poorer than traditional diets. According to Popkin et al. (2001), in this so-called "nutrition transition," people are adopting diets that are higher in energy (more added sugar and fat) and have less nutritional quality. At the same time, physical activity is reduced both in work and free time. This leads to obesity and other health problems. In this context, Johns and Sthapit (2004) argue that it should be a policy priority to promote a diverse diet including a lot of indigenous foods (fruits, vegetables and whole grain products) and a proper amount of animal products.

Rosinger et al. conclude that "western" market foods in developing countries provide extra sources of fat and calories, which might be useful in the short-term but lead to obesity and other health problems in the long-term. Nardoto et al. (2011) confirm that urbanization in the Brazilian Amazon has caused notable changes in dietary habits.

In addition to many important components of the diet, forests also offer a diversity of traditional medicinal plants. According to Shanley and Luz (2003), traditional medicines are used by people from different socioeconomic classes in the eastern Amazon, but are especially important for the poor. According to their 9-year market study in Belém, nine out of the twelve top-selling medicinal species are native. Many people rely on these plants as a health care option because they are cheap, efficient and have cultural meaning. Medicinal plants are an important health care option for the rural and urban poor in Pará where the healthcare system is weak and unemployment is increasing. However, Shanley and Luz (2003) suggest that forest degradation has decreased the availability of many medicinal species including copaiba and andiroba. Many of the medicinal plants come from trees. Lima

et al. (2011) found that 40 out of 46 medicinal plants in their study site (Sustainable forestry district of BR-163) in the state of Pará are from tree species, with only a few from other sources (e.g., bushes and lianas).

Challenges in the trade of non-timber forest products (special characteristics)

The literature commonly includes lists of challenges or barriers to commercialization of NTFPs. For example, Aiyeloja and Ajewole (2006) cite seasonal variation with the greatest supply and lowest prices in the rainy season; availability of substitutes (agricultural or other products); transportation costs; lack of credit; and labor intensive collection. Paudel et al. (2009) add unsustainable harvesting and production practices to the list of challenges for commercializing Lokta paper and Allo herb in Nepal. Below, we draw on this literature to identify several broad categories of challenges facing actors in the NTFP supply chain.

Production

The challenges with marketing NTFPs start with the production process. According to Belcher and Schreckenberg (2007), because NTFPs are normally harvested from the wild forest, the collection and harvesting process tends to be complex and time consuming. In addition, collectors often do not have clear land tenure to the forest. Many forests in developing countries are essentially open-access for collection of NTFPs, which can lead to over-collection and conflict when products become scarce. The variability in production and decreasing availability of NTFPs (due to logging of dual purpose species and deforestation) are also challenges in some regions (Shanley, 2002). Pandit et al. (2010) suggest that the local people should be responsible for the management and accessibility of forests. They suggest permits for collection of NTFPs, group marketing and community forestry.

Perishability

Many of the most important NTFPs in local markets are fruits (uxi, piquia and bacuri in our study) and perishability is a challenge for these products. Perishable products should be stored and handled carefully and transported quickly to the market (Belcher & Schreckenberg, 2007). However, transportation is often problematic in the Amazon. Road conditions are very challenging, especially during the rainy season. Depending on the origin of the products, transportation to market might take several days. Shanley et al. (2002) notes

that native fruits are harvested during the rainy season in the eastern Amazon, making transportation even more challenging. Sometimes river transportation is the only option, and it can be very time consuming.

Saha and Sundriyal (2012) note, that most of the products (fruits and other plant parts) in their study are consumed raw. They say that NTFP profit could be increased significantly with semi-processing and grading. However, Barbosa de Lima (2011) finds that many consumers prefer fresh products, in their case fresh fruit pulps instead of frozen pulps in the fruit markets of Acre, Brazil. She mentions that fruit processing is controversial; it decreases the risk of some diseases associated with bad hygiene, but most consumers still prefer fresh pulp. She also raises interesting questions about future prospects for NTFP consumption, such as "Will consumers change their preferences in order to attain a safe product? If so, instead of purchasing fresh pulps from small producers they would rather buy frozen pulps at the supermarket, or the refrigerated pulp. Will the mass population traditionally consuming fruits everyday afford this change?"

Prices

According to Shanley et al. (2002), the prices paid for fibers and medicinal barks are quite low compared to the time required for transportation as well as collection. They find that collection of native fruits (piquia, bacuri and uxi) is more promising in their case study region of Capim, because fruits are available in larger quantities (reducing per-unit collection costs) and can be processed into different products (increasing market demand). In addition, native fruits have strong cultural value and therefore are not at risk of being substituted by other products. Nonetheless, they suggest that it might be more reasonable for the communities in Capim (located 137 miles from Belém) to sell their NTFPs to nearby villages and towns instead of Belém. Almeida et al. (2009) analyze trends in prices and quantities of some of the main non-timber forest products in Brazil during the time period 1982 to 2005. Marketed quantities fell for 22 out of 28 products (including Brazil nut), which they attribute

to decreased supply and demand. Marketed quantities increased for only five products including copaiba (which experienced price decreases due to supply outstripping demand) and açai (which had quite stable prices). However, in general, they suggest that supply of many NTFPs is declining due to increasing harvesting costs and/or traditional harvesters exiting the business. This might be a consequence of deforestation, forest fires and unsustainable harvesting of some of the products.

Lack of credit

According to Shackleton et al. (2007) some challenges that producers and sellers of NTFPs commonly face (especially if trying to expand their business) include lack of credit, poor technological resources, insufficient skills, and lack of organization. However, they believe that the situation of the producers and sellers could be improved with financial assistance, education and training about marketing, elimination of trade barriers such as road taxes and bureaucracy, and assistance for producers and sellers to create associations. Aiyeloja and Ajewole (2006) also cite lack of credit, and Paudel et al. (2009) cite lack of funding as key challenges in the trade of NTFPs. Uddin et al. (2007) identify improved access to credit, technical support and improvement of market facilities as key issues for fruit sellers in Bangladesh.

Forest degradation and over-exploitation

Forest degradation and decreased availability of NTFPs are widely noted concerns in the NTFP literature. Saha and Sundriyal (2012) investigate NTFP diversity, consumption and income from NTFPs in their study in tribal communities in northeast India (a total of 343 NTFPs were reported). They find that NTFPs are in high demand and really important for the local livelihoods. However, they raise concerns that "outside demand" will place increasing pressure on NTFP supply, possibly leading to forest degradation and other sustainability issues.

Monteiro et al. (2010) review studies of local markets for medicinal plants and find that a common theme is local dependence on the traditional medicines because they are normally cheaper. However, local people appear not to understand that these species might become extinct. For example, they note that "Almeida and Albuquerque (2002), for example, discussed the plant and animal species from northeastern Brazil that are vulnerable to extinction due to their systematic extraction and predation, but not a single management plan has been put into place to mitigate the effects of these practices."

Alves and Rosa (2010) study the trade in animals used in traditional medicine in Brazil. They conclude that the end-consumers who drive the market are often either unaware or just ignore the fact that animal trade is illegal in Brazil. Even though some of the animals are known to be endangered, they are still commercialized. In fact, the very scarcity of the species increases their value.

FAO's book about Amazonian trees (Shanley et al., 2011) also raises concerns about forest degradation. For example, it is noted that the availability of uxí has decreased a lot in the markets and the price of the fruit has risen. It used to be called "fruit of the poor", however, not anymore. Fortunately, there are some communities who manage and conserve uxí trees and therefore are still able to supply the markets.

Many NTFPs are harvested from multipurpose trees, which increase the pressure on these trees. Herrero-Jáuregui et al. (2009) find that out of 200 tree species harvested for timber in the state of Pará, 93 also offer non-timber forest products. 39 of these 93 species are used for commercial timber and non-timber products (with the rest used for subsistence). Of these, 23 (11%) have medium high timber value and only 4 (2%) have both high timber and NTFP value. These four species that are most at risk due to their dual use: D. odorata, T. serratifolia, T. impetiginosa and H. courbaril.

Management, cultivation and domestication as an answer

The literature also suggests possible solutions to the conservation threats posed by trade in NTFPs. Alves and Rosa (2010) suggest substituting domesticated animals as one potential solution to the conservation threats posed by this trade. Monteiro et al. (2010) suggest cultivation (domestication) of trees, using substitutes, and research on bark regeneration to address sustainability challenges in the production of medicinal tree barks. Ruiz-Perez et al. (2004) suggest cultivation and more intensive forest management as ways to help to maintain the supply of NTFPs, when species are threatened. Secure land tenure become even more important when NTFPs are cultivated. In their analysis of 61 cases Ruiz-Perez et al. (2004) conclude that managed and intensified systems present the best opportunities for income generation (i.e., transition from collection to cultivation) and the best solution for nature as well (e.g., reducing forest degradation). Peres et al. (2003) make a similar argument: "Without management, intensively harvested populations will succumb to a process of senescence and demographic collapse, threatening this cornerstone of the Amazonian extractive economy." On the other hand, Silva et al. (2010) call for improved infrastructure and manufacturing processes to help harvesters earn higher and steadier income from oils such as copaiba and andiroba and to create incentives to conserve the species.

Uddin et al. (2007) study the local and urban fruit markets in Bangladesh and find out that demand for some of the most popular local fruits are increasing, but decreasing for some other fruits. They think the decreased demand is because people do not know these fruits really well and because there are not so many sources left. They recommend government and NGOs to improve the situation by facilitating (technical and other support) the cultivation of local fruit species in "homestand" agroforestry systems and utilize the waste land and other vacant places for planting of fast growing, profitable local fruit species.

Pandit et al. (2010) study the domestication of five NTFPs in eastern Nepal, finding that all of the NTFPs are more profitable than agricultural crops. However, farmers do not use

NTFPs a lot. The main factors affecting the domestication of NTFPs are found to be skill and knowledge, how often forests are visited, accessibility of forests, permit and trading system as well as market uncertainty among other things.

Mutenje et al. (2011) find out in their study of NTFP management in south-eastern Zimbabwe that the main reasons to increasing forest degradation are related to resource scarcity, limited market integration and infrastructural development. Instead, income from livestock, high ecological knowledge, and effective local institutional management of the commons are likely to reduce resource depletion. Mutenje et al. (2011) conclude that these results would suggest that there is a need for local management systems that emphasize the ecological knowledge of users and that are able to regulate market structure so that it would favor "long-term livelihood securities of these forest-fringe communities."

Bussmann and Zambrana (2012) note that the global boom in demand for fruit from *Euterpe* sp. has shifted use of the species from construction materials to different kinds of food products and increased the pressure on natural populations. The increased demand for açai is at least partly met by intensified systems, including a range of agroforestry systems ranging from intensive production systems to more extensive management by the traditional riverine ("caboclo") population (Brondizio, 2004). Although açai was traditionally used as "food" primarily in the eastern Amazon, it is now being cultivated even in western Amazonia. Brondizio (2004), referring Brondizio (1996) and Brondizio et al. (2002), notes that acai's "price index has followed and surpassed the inflation rates of most agropastoral products of the state (Pará)".

Methods employed in previous studies

Because there has been little research on local or regional markets of NTFPs, especially on consumers in these markets, I expanded my review of methods to include studies of regional markets for horticultural products in Brazil.

Local markets for NTFPs have been studied with surveys or structured interviews of market participants, but very few of these have considered consumers. Mukul (2007) investigated NTFP product diversity, marketing patterns and challenges based on interviews with 25 randomly selected NTFP traders and 12 consumers in 2007 and 2008 in the Sylhet Sadar region in Bangladesh. Traders were interviewed with a semi-structured questionnaire including questions about the diversity and names of products sold in their stores. Both qualitative and quantitative data were collected. The twelve consumers were selected through convenience sampling in the stores and were asked a series of open-ended questions. Aiyeloja and Ajewole (2006) researched markets for NTFPs (emphasizing chewing sticks and bush meat) in Osun State, Nigeria. They randomly selected five local government areas and applied 300 questionnaires (150 for each product) concerning production, marketing and consumption of these products (50 questionnaires for each sub-area). They tested whether educational background and income affect the consumption of chewing sticks and bush meat using Chi-square. They find that bush meat is considered a delicacy especially in urban centers. However, its consumption is relatively low compared to other animal sources. The use of chewing stick is not related to income or education, even though it is cheap (compared to tooth paste). Some people report using it because they believe it makes their teeth stronger.

There have been more studies of vendors or traders of NTFPs. Most relevant to this thesis is Shanley (2003) who studied the market for medicinal plants in the Brazilian Amazon. In 1994, she conducted a baseline survey in 23 plant establishments, eliciting a list of all of the different species on sale in each establishment. The origins of the 200 different plants recorded were checked from local botanists, after which store managers and vendors were interviewed in order to find out top selling plants, prices, and volumes. Via semi-structured

interviews, she obtained information about the trends in sales, customer demand and consumer population. During the study period (1994-2002), the owners and vendors of the main medicinal outlets and wholesalers were interviewed every second year to track trends in sales. In addition, a survey of 200 households, drawn from a socioeconomically stratified sample of Bélem, was implemented in order to find out the non-market sources for medicinal plants.

In contrast to the small literature on markets for NTFPs, there is a large body of research on regional markets for horticultural products in Brazil. Here, I briefly summarize both their findings and their methods. All of the studies described below employed teams of interviewers to conduct face-to-face interviews. The studies of consumers generally found that many factors in addition to price are important to consumption decisions. For example, Costa & Oliveira e Silva (2011) studied vegetable markets in the city of Pombal in northeastern Brazil in 2008. Interviews were completed with 60 consumers to elicit their socioeconomic profile and consumption habits. They found that most shoppers are female, and that they consider inadequate hygiene, lack of organization and the changing stalls as the main problems in the market.

In the fruit market in the metropolitan area of Recife, Bezerra Barros et al. (2008) found that consumers prefer bananas that are big, with clean peel, mature and no chemicals. Price was not the main factor in the buying decision. They interviewed a large sample of 1677 consumers, which was stratified by place including 427 interviews in supermarkets and 1250 in open-air markets, all conducted in 2005. The questionnaires were structured with open-ended questions and the interviewing method was informal.

An interesting study of consumer preferences in fruit and vegetable market was implemented in 11 counties of Rio Grando do Sul. Places of interviews were chosen with stratified sampling using different criteria for different regions. Overall, 266 consumers were

systematically chosen to interview. Questionnaires included questions about consumption habits, consumer and socio-demographic information. Santos de Souza et al. (2008) found that most consumers buy the products from supermarkets (60%) a few times a week followed by fruit shops. However, in smaller cities, people buy mainly from fruit shops (54%) followed by supermarkets (23%). People chose the place where they buy mainly according to quality, variety and the speed (how fast they can do the purchase). The main factors affecting the purchase decision were quality and time spent, rather than price.

Silva (2010) analyzes the profile of consumers in an "agroecology" fair in the city of João Pessoa in January of 2010, finding that most are women and considered as occasional visitors. Another interesting observation is that the consumers are not interested in the environmental characteristics of the agroecological products but are rather attracted by the health benefits as well as the location of the market near to the place they live and the price of the products. This study has a small sample size; only 18 randomly chosen consumers are interviewed. Questionnaires include questions about consumer preferences, habits and socio-demographics.

One study focuses on the sellers' point-of-view. Tofanelli, Fernandes, Matins Filho and Carrijo (2007) found in their study of Fresh vegetables market in Mineiros that a lot of the products come from other states. Fresh vegetables are mainly sold in supermarkets and grocery stores and most of the products are coming from distant markets (81.8%). The study was implemented in December 2005 and January 2006 by interviewing owners of commercial establishments (supermarkets, grocery stores and street markets). Face-to-face interviews include questions about volumes and prices.

Materials and methods

Description of data collection

From 2006 to 2009, the Brazilian research institution, IMAZON, collected information on regional markets and commercialization of NTFPs, as part of a larger project called "Bridging the divide: Enhancing Forest Tenure, Management and Marketing in the Brazilian Amazon." IMAZON coordinated this project, which began in 2005, with the general objectives of contributing to the conservation of the Amazonian tropical forests and improving the quality of life of the people who depend on those forests (reference project website http://www.ncsu.edu/project/amazonia/brazil_proj/index.html).

The objective of the project component focused on NTFP markets and commercialization was to identify strategies for communities to capture greater market value from forest products. Specific objectives included identifying local and regional market niches for NTFPs, developing marketing plans for sale of NTFPs, and increasing consumer awareness of NTFPs. To support these objectives, a market survey of consumers and sellers of NTFPs was implemented during the years 2006 to 2009.[1] In the first year of the survey, interviews were conducted in several cities, ranging from small regional cities in the Amazon to São Paulo. Due to budget constraints, in the following years, the survey was only conducted in Belém, and thus I focus on the sample of consumers interviewed in Belém, the capital of the Amazonian state of Pará.

Sampling and survey methodology

In each year from 2006 to 2009, teams of interviewers – including mostly university students – were hired to conduct face-to-face interviews and enter the data into Excel spreadsheets, with training and supervision by IMAZON researchers. In each year, an intercept survey of

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[1] A "survey" is a data collection method using a questionnaire in order to obtain information from the people who are thought to have and be able to provide it (http://www.managementstudyguide.com/survey_method.htm).

consumers was conducted between February and April, which is the main season for most perishable NTFPs. The number of consumers interviewed varied across the years:

- 715 interviewed in 2006
- 653 interviewed in 2007
- 217 (408) interviewed in 2008
- 853 interviewed in 2009

The smaller sample size in 2008 reflects the number of observations for which complete data are available; due to an error in processing files, complete data are not available for all 408 consumers interviewed in that year.

Interviews were conducted in locations representing the three major types of sale outlets for NTFPs in Belém:

(1) Ver-o-Peso is the primary open-air market in the city and is famous for the diversity of products sold. This market is promoted as one of the city's tourist attractions, although in fact few tourists venture to make purchases there.

(2) The government has established locations for 44 open-air markets (or "fairs") in different neighborhoods of the city, sometimes under a roof with permanent booths, and sometimes simply an outdoor space where venders are authorized to set up their own booths. For this survey, nine fairs were selected using stratified random sampling in order to represent fairs of different sizes.

(3) Large supermarkets are capturing an increasing proportion of customers in Belém, and even the large national chains sell some regional products, including NTFPs. For this survey, a random sample of 20% of the three main supermarket chains in Belém was selected. Interviews were conducted in 6 supermarkets.

The interviewing teams visited different locations on a regular rotation and were trained to approach roughly every third person, using standard street intercept methodology to obtain a

random sample of visitors to the stores and open-air fairs. So for example, if one person refused to be interviewed, they would next approach the third person that passed by. Interviewers used a closed-ended survey instrument, following standard interviewing methodology. There were seven different versions of the questionnaire (six in 2006), each of which focused on a different NTFP (described in the following section). The interviewers used one version of the questionnaire with each respondent, working through the versions systematically so as to avoid bias based on which types of consumers were asked about which NTFP. This approach was taken in order to (a) ask about a diversity of important medicinal and edible NTFPs, (b) make the questions more concrete by referring to a specific NTFP, but (c) keep the interview short in order to avoid having respondents break-off in the middle of the interview.

Description of the focal products

The survey focused on the most prominent NTFPs in the markets in Belém, as identified through preliminary canvasses of markets, interviews with vendors, and review of the literature. The seven focal products included fruits (açai, bacuri, piquía, uxí), oils (andiroba and copaiba) and one nut (Brazil nut). Each of these is produced by trees in the native Amazon forest. Each of the trees is multipurpose, but with a clear dominant use as described below.

Açai (*Euterpe oleraceae*)

Açai is a palm native to Pará estuaries, but it also occurs in the states of Amapá, Amazonas and Maranhão as well as in other countries such as Guyana, French Guiana and Venezuela. Its fruit is small and round, like a small grape, and grows in bunches of 500 to 900 fruits. Each tree normally produces from 4 to 8 bunches per year. Açai is harvested in the dry season, which is from July to December in the region around Belém. The açai fruit is mainly sold as frozen or fresh pulp to be used in juices, jams, ice creams and as flavor in other products. The other primary use of açai palm is for palm hearts (fresh or canned) or "palmito," which is the inner core and growing bud of the tree. Açai's leaves are used for

baskets and carpets, trunk for construction, seeds as fertilizers and for jewelry, roots for medicinal tea and stems as fertilizer.

International demand for açai has increased dramatically during the last ten to fifteen years due to its growing reputation as "super food". National demand has increased as well. The quantities sold and the prices vary throughout the year depending on the season. The prices go down in the peak season and up during the off season when there is not as much of the fruit available.
(FAO, Fruit trees and useful plants in Amazonian life)

Brazil nut (*Bertholletia excelsa*)

Brazil nut can be found in Amazonian forests in Brazil, Colombia, Venezuela, Peru, and Bolivia and in some parts of Guyana. It is one of the biggest trees in the area reaching large circumferences. Brazil nut is harvested for its fruit, which has 10-25 nuts (botanically considered as seeds). The harvesting season is from January to April. The production varies across years but is generally related to the size of the tree. Brazil nut is primary used for its nuts, which are often consumed fresh and also used in ice creams and sweets. The nut is also used to manufacture a spread and it is ground into flours. The oil squeezed from the nut is used in soaps, shampoos and creams. The shell of Brazil nut's fruit is also used to make crafts and toys, and its bark is used for medicinal tea to treat diarrhea.

Although there are a few plantations, Brazil nut is still harvested primarily from wild trees. Harvesters sell most of the nuts that they collect to traders who in turn sell them to large processing companies that dry and shell the nuts. The largest international markets are in the USA and England. Phytosanitary regulations only allow import of unshelled nuts into Europe, because of concerns over a fungus that occurs in the nuts. The collection, processing and sale of Brazil nuts is an important income source for many local people.
(FAO, Fruit trees and useful plants in Amazonian life)

Copaíba (*Copaifera sp*)

Copaiba can be found everywhere in the tropics, but it is especially abundant in Brazil, which has 16 different species. Copaiba's main product is its thick yellow sticky oil, which is extracted from the trunk. The oil extraction does not need a specific harvestings season, it can be done throughout the year. The oil production varies greatly between trees, the annual production being from 100ml to 60 litres/tree, although not all trees produce oil at all. The oil is drilled from 20 to 50 cm deep (to the center) from the trunk and tubing or pipe is inserted in order to get the oil to a container on the ground. In some places, the oil is extracted in rainy season (Acre) and in some areas in dry season (Pará).

Copaiba is known as the antibiotic of the forest. The oil is mainly used to close the growth of scar to wounds and to treat skin diseases such as psoriasis. It is also used to different kinds of infections, because of its anti-inflammatory properties. The oil is used in varnish, paint and perfume and it can be used in cosmetics (creams, soaps and shampoos) as well. Copaiba's timber is resistant to insects and it is used in civil construction and board manufacturing. The bark is used to make anti-inflammatory tea.

Copaiba oil is scarce in Belém due to deforestation and it is mainly coming from the surrounding areas. The price of the oil is really high compared to other NTFPs, but it varies quite a lot depending on how the oil is processed. Also, the packaging, whose selling the oil and where it is sold affect the price significantly. Copaiba oil is exported from Brazil to France, Germany and USA.

(FAO, Fruit trees and useful plants in Amazonian life)

Andiroba (*Carapa Guianensis*)

Andiroba occurs in Amazon basin, Central America and Africa. Andiroba is harvested for the seeds of its fruit. One fruit contains 12-16 seeds and the oil is extracted from the seeds. The harvesting season is from January to April. Andiroba fruit production is quite mysterious and the yield might be really different in different years. There are different extracting methods,

but normally first the seeds are boiled until they are soft, then they are spread on the ground covered with leaves for 40 days, after that the flesh is removed and made into balls which are softened with feet and hands (traditional). Andiroba is widely used as a medicinal oil to cure bruises, inflammation and other skin damage. It is also used in soaps, creams and candles. Andiroba's wood, which is considered as "false mahogany" is of excellent quality and resistant to insects. It is used in civil construction. Andiroba's bark is used to make tea against fevers, worms and tumors.

Andiroba oil is popular in Amazonia, but there is also international demand. The oil is exported to the US and Europe. The wood is exported as well.

(FAO, Fruit trees and useful plants in Amazonian life)

Bacuri (*Platonia insignis*)

Bacuri is native to Pará and occurs mainly in estuaries of the Amazon River. It is rare in the Western Amazon, but grows in parts of Colombia, Venezuela, Guyana, Suriname and French Guiana. It is mainly harvested for its fruit. Bacuri's fruit has thick skin and two seeds and about 10% pulp. One tree produces on average 400 fruits/year, but can produce up to 2000 fruits/year. The season for harvest varies by region, but is normally from January to April. The primary use of bacuri is the pulp of the fruit, which is consumed fresh and used to make juices, ice creams, sweets, liquor and other foods. Bacuri's oil and latex are used for treating skin problems, as well as its good quality wood, which is used for construction, furniture and boats.

The price of bacuri has increased in local markets during recent years. Large quantities of bacuri are sold especially in the open-air markets in Pará and it is one of the most popular fruits in the wholesale markets of Belém, Teresina and São Luís. One advantage of bacuri is its thick skin, which protects the pulp inside, when transporting the fruit to the market place.

(FAO, Fruit trees and useful plants in Amazonian life)

Piquía (*Caryocar villosum*)

Piquía can be found almost everywhere in Amazonia, but is the most abundant in upland forests near large estuaries. It is harvested for its fruit, which is grapefruit-sized tan fruit. The tree gives fruits from February to April, often every second year. Piquía's fruits drops by themselves from the tree. The primary use of piquía is its fruit's yellow oily pulp, which should be boiled before use. Wildlife eats the flowers. The wood of piquía is of high quality and it is used for constructions and for boatbuilding. Oil from the pulp can be used in cooking and oil from the seeds could be used in cosmetic industry. The rind has some end uses as well such as soaps and ink.

One piquía fruit cost US$0.40 in the Ver-o-Peso market in January 2009 and the previous year the price was about the same. In 2008, one liter of piquía oil cost about US$21.

(FAO, Fruit trees and useful plants in Amazonian life)

Uxí (*Endopleura uchi*)

Uxí is native to Brazilian Amazon and it's harvested for its fruit. The fruit is egg-sized and has pits that are covered by oily pulp. Uxi's harvesting season is from February through May. Most of the trees are producing between 700 and 2000 fruits per year, even though the number might vary a lot in different years. Uxi can be eaten raw, but it is more popular in a form of frozen treats, ice cream, juice and oil. Uxi's wood is used for carpentry and a powder, which is inside the seed is used for medicinal and cosmetic purposes. Uxi has some secondary uses as well: its bark is used for making tea and the fruit has also artisanal uses and it is eaten by many animals.

The price of the fruit and pulp are increasing as well as the price of the powder. Uxi has become a popular ice cream flavor. Earlier there were a lot of trees for sale, but now it might be difficult to find a sapling in Belém.

(FAO, Fruit trees and useful plants in Amazonian life)

Description of the study site

Belém

Belém is the capital of the state of Pará in the North of Brazil. The city lies on the Pará River, near the mouth of the Amazon River system. Belém has a tropical rainforest climate. The Amazon culture can be strongly felt in Belém (Belém, 2012).

According to the socio-demographic census, the population of Belém was about 1.39 million people in 2010. The territorial area of the city is about 1,059 km^2, and thus the population density is 1,315 inhabitants per km^2. The average monthly per capita household income was R$697 (Brazilian reais) in 2010 (396 US dollars, at exchange rate on 07/14/2010 reported by oanda.com), compared to the national monthly minimum wage per person of R$510 in 2010. Median monthly income for men (47% of the population) was R$700 and for women (53% of the population) R$510 GDP per capita in 2010 (at current prices) was R$12,922 According to the census in 2003 the poverty incidence in Belem was 40.6%, compared to 28.1% for Brazil as a whole. Belém had a Gini Index of 43 in 2003, lower than the national Gini Index of 58.8 (IBGE). The Gini Index measures the distribution of income, with 0 representing perfect equality and 100 perfect inequality.

NTFP markets in Belém

In Belém, NTFPs are sold in open-air markets, harbors, supermarkets, small food shops or groceries and specialty stores, as well as by mobile vendors. Open-air markets or fairs are authorized by local government, and sellers operate from stalls or booths.[2] This distinguishes them from informal street vendors who sell NTFPs from their carts or in the big intersections by simply walking up to cars stopped at the light and offering NTFPs for sale. Harbors are busy places where the NTFPs are delivered by boat from nearby locations and sold to venders from open-air markets, supermarkets and other stores, and directly to consumers. In addition to products sold nationally, supermarkets also sell regional specialties, including NTFPs. In addition to the large supermarkets that are part of national chains, there are other small food stores or groceries that are usually locally owned. Belém also has specialty stores including natural pharmacies and ice cream stores that sell products made with NTFPs. In this study, interviews were conducted with consumers shopping in the open-air markets and in grocery stores that are part of national supermarket chains.

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[2]The most famous open-air market is Ver-o-peso, which is located on the riverfront in the heart of Belém. The city's official website describes the Ver-o-Peso as follows:

> "The Ver-o-Peso street market exposes the fresh air of Amazon in its tents every day. Early in the morning, the boats arrive with açaí, fish and many other goods from the islands around Belém. The Guajará Bay celebrates throwing its breeze over the meat and the fish markets, built with iron brought from England in Portuguese ships. There isn't a single tourist who resists the perfume of patchuli, and the power of the herbs, which overcome all problems, such as love."
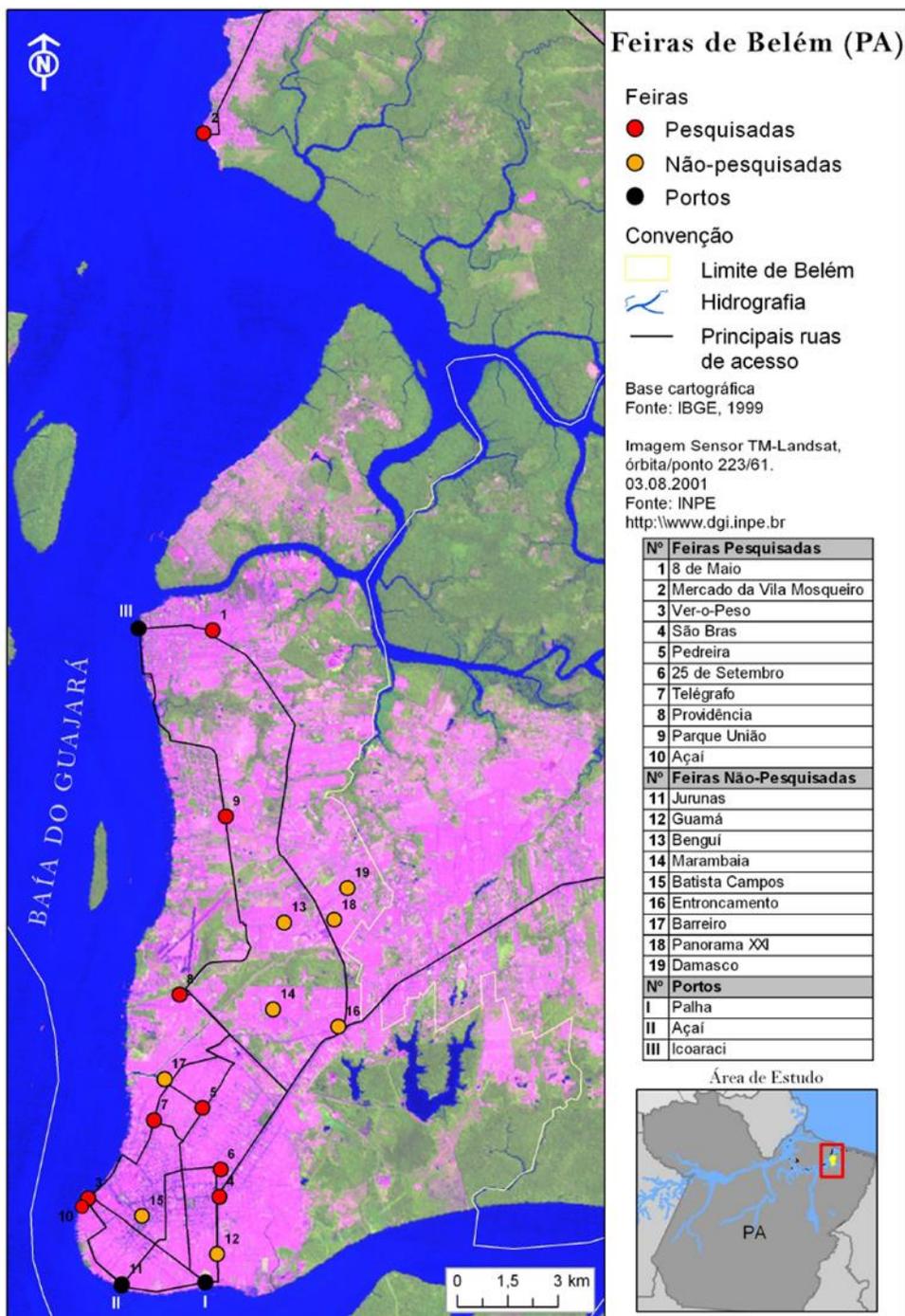
Figure 1. Open-air markets in Belém

Methodology

Here, I describe the methodologies employed to analyze data from the surveys described in the previous section, in order to address my two broad research objectives. The aim of the first section is to describe who is buying NTFPs and identify trends in consumption across the four years of the survey. The objective of the second section is to develop a market segmentation analysis, identifying, characterizing, and identifying trends for different types of NTFP consumers. Both analyses required significant data cleaning and processing as a first step.

Survey data

For my analysis, I selected and created variables that are consistently defined across all four years of the survey. The survey elicited information on consumption of NTFPs in general, purchase of focal products, and socio-demographic characteristics. In each year, there were seven different versions of the questionnaire, each of which focused on a different NTFP: açai, brazil nut, bacuri (except 2006)[3], copaiba, piquía, uxí and andiroba. These seven NTFPs are called the "focal products." Consumers were asked about how frequently, where, and at what price they purchased the focal products.[4]

The survey instruments elicited a general socioeconomic profile of consumers (and vendors), with a core module of the questionnaire maintained in every year, but variation in other questions, largely reflecting efforts to learn from previous years and improve the questions and answer categories. In 2006, the questionnaire was quite simple and can be viewed almost as a pilot survey in preparation for the more complex and consistent survey instruments used in 2007, 2008 and 2009. The number of questions ranged from 24 questions in 2009 to 33 questions in 2007. This variation in the questionnaire places limitation on the analysis and

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[3] Bacuri was frequently cited by consumers in response to an open-ended question in 2006, and thus was added to the questionnaire in 2007.

[4] The questionnaires from each year can be obtained from
http://www.ncsu.edu/project/amazonia/brazil_proj/ferramentas.html#quest_mercado

interpretation of the data. In some cases, particular questions or hypotheses could be addressed with data from one particular year only, but my focus is on trends over time and thus, I focus on responses to questions that were posed consistently across years.

In order to address my research questions, I concentrate on responses to the following questions:

What products do you use that are from the forest? (Respondent could list 8-10 products)
On which products do you spend the most money?
Where do you most often buy the product?
How much do you pay for the product?
Which of the focal products do you use? (Mark each that apply) (Was not asked in 2006)

And Socio-demographics:
Gender
Age
Place of birth
Household size
Number of children
Wage
Have you entered the forest?
Do you have higher education?

Data processing

The survey data were entered into MS Excel spreadsheets by the interviewers, including the names of the various NTFPs mentioned by respondents. In order to analyze these data, I coded and categorized all of the different forest products people listed in response to the question: "Which forest products do you use?" The categories that I considered are edible

NTFP, medicinal NTFP, animal NTFP, other NTFP, NTTP (non-timber tree product not native to Amazon forest), and non-tree products. In addition, to analyze trends in socioeconomic characteristics, I converted the income categories used in each year to US dollars using the value of the minimum wage in 2006 and each year's exchange rate between the real and US dollar.

Descriptive statistics and trends

I provide descriptive statistics of the socio-demographics in the first section of results. In addition, I describe the general trends in the consumption of non-timber forest products, and in more detail, the focal products, which are reported by year and by market type (place of interview[5]). The figures and tables are constructed in SPSS and EXCEL. For most of the focal products, I have sufficient information on prices to calculate their mean, median, minimum and maximum by year. In addition, I calculate the annual rate of change in prices with the following formula:

$$\textbf{\textit{Rate of change}} \, (\%) = \textbf{\textit{r}} = \sqrt[3]{\textbf{\textit{price in 2009}}/\textbf{\textit{price in 2006}}} - \textbf{1}$$

To assess whether the data from each year can be pooled, I test for differences across the years by using pairwise comparisons; t-tests with scalar variables and z-tests with proportions. I am using alpha level of 0.05.

Cluster analysis

Cluster analysis is a good tool for segmenting the market. It helps identify homogenous groups within a larger more heterogeneous group. Cluster analysis can be used to find

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[5] Consumers may purchase NTFPs in more than one type of market, however people interviewed in supermarkets/Ver-o-peso/fair were more likely to say they purchase from supermarkets/Ver-o-peso/fair.

specific groups of consumers that are distinct in terms of their behavior and attitudes, lifestyle, or demographics including gender, age, income or any other characteristic (SPSS, 2001).

To segment the market for NTFPs in Belém, I cluster respondents according to their reported consumption of NTFPs and then examine how socio-demographic characteristics vary across these clusters. Specifically, I create clusters based on answers to two open-ended questions about "Which forest products do you use?" and "On which product do you spend the most on? (SPENDMOST)" Both of these questions are described in detail below. Respondents were able to list freely up to eight (ten in 2006) forest products. I analyze patterns of consumption based on counts of products listed in different categories.

I use SPSS's two step cluster analysis, which is generally recommended for large datasets including both categorical and continuous variables (Garson, 2012). An advantage of two step cluster analysis is that the number of clusters does not have to be specified (SPSS, 2001). However, I also compare results with k-means clustering, which is more commonly used in market segmentation studies.

The specific variables used in the cluster analysis are as follows:

EDIBLE = the number of edible NTFPs the respondent reported in the question "Which forest products do you use?"

MEDICINAL = the number of medicinal NTFPs the respondent reported in the question "Which forest products do you use?"

ANIMAL = the number of animal NTFPs the respondent reported in the question "Which forest products do you use?"

OTHERPROD = the number of other than previously mentioned (edible/medicinal/animal) NTFPs the respondent reported in the question "Which forest products do you use?"

SPENDMOST = the NTFP category (edible/medicinal/animal/other) on which the respondent spends the most

To check the robustness of the cluster solutions, I consider different numbers of clusters, different numbers of variables, and clusters created with count variables treated as either ordinal or scale variables. The count variables are Edible, Medicinal, Animal, and Otherprod. The question about "which forest products do you use?" was intended to elicit a complete listing of products used, which would mean that these variables are scalar. However, it is also possible that respondents did not remember all products, and thus the number of products mentioned could be interpreted as an indicator of whether they consume few, medium, or many different products; under this interpretation, the variables are ordinal. Thus, the four main solutions considered are as follows:

Four-cluster solution with the count variables as ordinal
Five-cluster solution with the count variables as ordinal
Four-cluster solution with the count variables as scale
Five-cluster solution with the count variables as scale

The different options are described in Figure 2. In the two-step ordinal variable solution and the k-means solution, three variables out of five were found to be significant (i.e., important in forming the clusters), whereas in two-step scalar variable solution, all five variables were found to be significant.
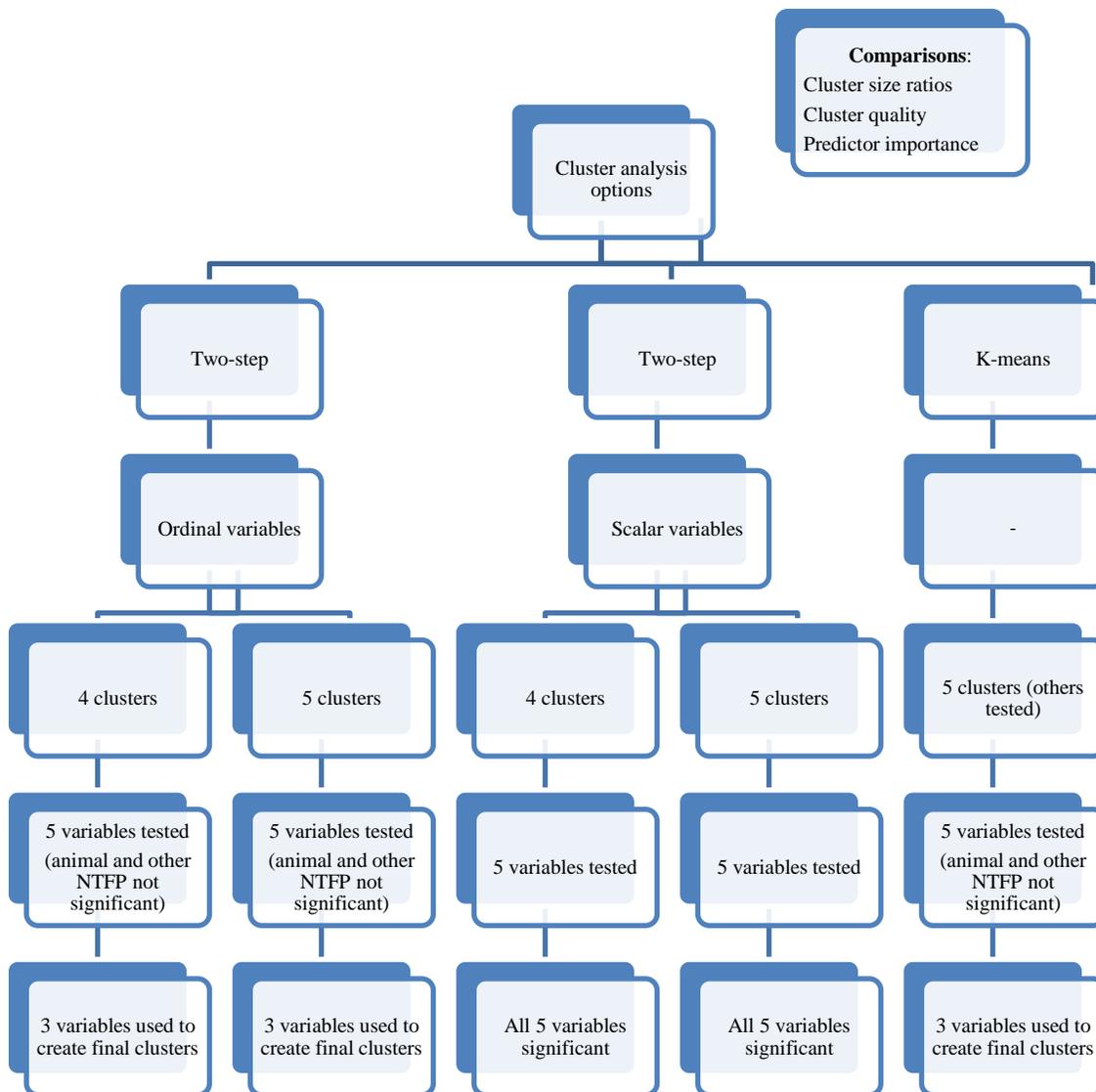
Figure 2. Cluster analysis options

I compare the possible solutions based on the predictor importance, ratio of largest to smallest cluster size, the distinctiveness of clusters in terms of socio-demographic characteristics, and the "silhouette measure" generated by SPSS. According to Mooi & Sarstedt (2011) the silhouette measure "is essentially based on the average distances between the objects and can vary between -1 and +1. Specifically, a silhouette measure of less than 0.20 indicates a poor solution quality, a measure between 0.20 and 0.50 a fair solution, whereas values of more than 0.50 indicate a good solution."

First I included all five variables in the analysis. With the count variables treated as ordinal, animal NTFP and other NTFP did not have significant predictor importance (their importance was less than 0.05 in a scale of 0 to 1.00 and where the importance of edible NTFP was 1.00) and therefore they were excluded from the final ordinal variable solutions. When count variables are treated as scalars, animal NTFP in particular has significant predictor importance (animal NTFP had importance of 1.00 and other NTFP importance of 0.7 on a scale of 0 to 1.00) resulting in the use of all the 5 variables. The role of animal NTFP and other NTFP was the main difference in the ordinal variable and scale variable solutions. Ordinal variable solutions had quite evenly sized clusters (ratio of the clusters sizes was under two), whereas in the scale variable solutions there were niche segments mainly based on animal NTFP consumption including one cluster with less than 2% of the total amount of respondents.

In addition, I checked whether the different options generated distinctive clusters in terms of socio-demographic characteristics by estimating descriptive statistics and comparing the patterns. The strongest differences between the clusters appeared in the ordinal variable (5-cluster) solution. I checked the socio-demographics patterns for the 5-variable-solutions as well, but there were almost no differences compared to the 3-variable-solutions. There was no single clustering option that stood out as generating the most distinctive clusters in terms of socio-demographic characteristics.

All of the cluster solutions had silhouette measures in the "good" range. The largest silhouette measure was for the scale variable solution with five clusters. K-means clustering produced slightly different results than two-step cluster analysis. K-means resulted in a solution with one notably bigger cluster than the others, two-medium size clusters and two niche clusters. However, the segments had similar characteristics as those identified by two-step cluster analysis: the largest cluster had no reported consumption (still spending the most on edibles); the two medium clusters had moderate consumption and high consumption; and the niche segments were characterized by very high consumption and consumption of diverse NTFP categories.

Results

The results are presented in two sections. The first section describes the market for NTFPs in Belém, providing a rich description of consumer demographics and purchasing behavior and identifying patterns and trends across the four years. The second section assesses whether distinct market segments can be identified based on consumers' self-reported purchasing behavior, which in turn reflects both use and knowledge of NTFPs. By using cluster analysis to segment the market, I identify and describe a typology of NTFP consumers in one of the most important regional markets in the Amazon Basin. The more detailed content of the sections is described below:

1) The first section describes the typical NTFP consumer in Belém and then differentiates the typical consumers in different types of sales outlets (Ver-o-peso vs. neighborhood markets vs. supermarkets) and identifies time trends. Overall statistics on NTFP consumption are provided including the most common products (and their prices) in each year and in each market type. These products are also characterized and categorized, e.g. according to whether they are perishable or non-perishable.

2) The second section presents the results of a market analysis including a typology of consumers developed with cluster analysis. Consumers with different NTFP consumption profiles are identified and described.

Section I: Characterizing and identifying trends in the consumer market for NTFPs in a major regional market center in the Brazilian Amazon

Because the consumer survey was conducted by random intercept sampling in and near sales outlets for groceries and food, the overall sample characteristics provide some insight on the consumer market in Belém[6]. We first characterize the consumers in the market, then the NTFPs that they report consuming. This list of products reflects both consumption patterns and consumer knowledge (or lack of knowledge) about non-timber products from the native Amazon forest that surrounds their city.

Socio-demographics

This section concentrates on the socio-demographics of the sample population. I examine trends across the four years of the study (however, not all variables are available for 2006) and compare sample characteristics to Belém's 2010 Demographic Census.

As shown in Table 2, more than half of the respondents were women, with a particularly high proportion in 2007 (69% female). This is consistent with classic gender roles that assign grocery shopping to women. According to the Demographic census 2010, 52.7% of the whole population of Belém is female.

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[6] The primary caveat on using the sample to characterize consumers in Belém is that the proportion of Belem's consumers who shop in the Ver-o-Peso, neighborhood markets, and supermarkets is not known, and the sample may therefore be weighted incorrectly across locations.

Table 2. Gender, place of birth, education and whether the respondents have entered the forest

Variable	Year							
	2006		**2007**		**2008**		**2009**	
Gender								
Female	56.8%	(406)	69.0%	(448)	59.6%	(242)	51.9%	(439)
Place of birth								
Belém	49.7%	(355)	55.6%	(360)	56.5%	(230)	67.3%	(571)
Have you entered the forest?								
Yes	n/a		65.1%	(421)	64.1%	(261)	58.0%	(492)
Tertiary education								
Yes	n/a		29.1%	(179)	20.5%	(44)	23.7%	(199)

Note: The percentages are proportions of respondents who are female/born in Belém/entered the forest/have tertiary education. Numbers in parentheses are the counts of the percentages (ex. 406 of the respondents were females in 2006)

The proportion of respondents born in Belém increases across the years (Table 2). 49.7% of the respondents reported that they were born in Belém in 2006, whereas 67.3% reported the same in 2009. The proportion in 2009 was statistically different from the proportions in other years.

Entered the forest

In addition to standard socio-demographic characteristics, familiarity or affinity with the forest may also be important in NTFP markets. Table 2 shows the percent of respondents who had entered a forest, in the three survey years when this information was elicited[7]. In

[7] The question was asked in a following way:" Você já entrou na floresta?" with the answer categories: "
( ) Não ( ) Sim: quantas vezes? ( ) 1 ( ) algumas ( ) muitas ( ) morei ou trabalhei lá "

each year, more than half of the respondents report that they have been in the forest, with the percentage varying from 58% to 65%. There is a statistically significant difference between 2007 and 2009. It is striking that up to 42% of respondents in a city deep in the Brazilian Amazon, with forest clearly visible from its riverfront, have not ever entered the forest. This shows that we cannot assume consumers in regional markets are familiar with the forest, as they may be leading a highly urbanized life.

Education

Not all of the socio-demographic questions were asked in every year of the survey. For example, respondents were asked whether they had *any* tertiary ("higher") education only in 2007, 2008 and 2009, with results shown in Table 2. According to the 2010 census, only 6.3% of Belém's residents have *completed* higher education. While noting that the survey responses include those who are studying at the moment as well as those who have completed higher education, it appears that the people in the survey sample are more educated than the overall population of Belém.

Table 3. Age, number of family members and number of children

Variable	Year			
	2006 **Mean**	**2007** **Mean**	**2008** **Mean**	**2009** **Mean**
Age	41_a	43_a	42_a	36_b
Number of family members	4.8_a	4.4_b	$4.5_{a,b}$	$4.5_{a,b}$
Number of children	1.26_a	1.01_b	1.01_b	1.06_b

Note: Values in the same row and subtable not sharing the same subscript are significantly different at $p < .05$ in the two-sided test of equality for column means.

Age

Mean age of the respondents was almost the same in 2006 (41 years), 2007 (43 years) and 2009 (42 years), however, it decreased statistically significantly in 2009 to 36 years (Table 3). The age distribution of the respondents in each year is represented in the Appendix A. The distributions are close to normal, except for the high proportion of people in the age range of 30-35, suggesting that people in this age range are more likely to be responsible for shopping in the markets. According to the 2010 Census, the largest group of women in Belém are aged 20-24 years old and the largest group of men are aged 25-29 years old, meaning that our sample is older than the population of Belém.

Number of family members

The mean family size was between four and five in every year of the survey (Table 3). The distribution of family size can be seen in Appendix B. The greatest number of respondents had family sizes of three, four or five. The distributions are skewed to the right, influenced by a small number of people with really big families.

Number of children

The mean number of children was one in each year of the survey. However, the mean in 2006 is statistically different and higher (1.26) than in the other years. The distributions of the number of children in each survey year are portrayed in Appendix C. In every year, the single largest category of respondents had no children. Few people have five or more children, but the distributions are skewed to the right because of a few respondents with large numbers of children (Appendix C).

Income

Monthly household income was elicited in every year of the survey (in Brazilian reais), but a different scale was used to record the answers in 2006 compared to the other three years. In 2006, the answer categories were the following:

- 1-5 minimum salaries   =   R$300 – R$1500/month
- 6-10 minimum salaries   =   R$1800 – R$3000/month
- 11-15 minimum salaries   =   R$3300 – R$4500
- 16 or more minimum salaries =   more than R$4500

(Currency exchange: Oanda,com 12/31/2006)

In other years the categories for monthly household income were the following:

- 0 a R$500   =   US$0 – US$220 to US$ 285
- R$501 a R$1000   =   US$220 to 285 – US$424 to 570
- R$1000 a R$1500   =   US$424 to 570 – US$640 to 860
- R$1501 a R$2000   =   US$640 to 860 – US$850 to 1140
- R$2001 a R$3000   =   US$850 to 1140 – US$1270 to 1710
- R$ 3000 a R$4500   =   US$1270 to 1710 – US$1910 to 2570
- More than R$4500   =   More than US$1910 to 2570

(Currency exchange 31/12 each year: Oanda.com. Note: the smallest US$ amounts are for 2008 and largest for 2009.)

The income distribution in each year is displayed in the figures in Appendix D. In every year except 2009, the greatest number of respondents reported being in the lowest income category used in the survey, equivalent to US$0 – 280/month in 2007 (exchange rate for 12/31/2007 from oanda.com), US$0- 210/month in 2008 (12/31/2008, oanda.com) and in

2006 US$140 – 700/month (12/31/2006, oanda.com). In 2009, the greatest number of respondents were in the next higher income category, US$286 – US$572/month (12/31/2009, oanda.com).

Mid-point household income

The following table (Table 4) presents descriptive statistics for household income calculated by using the mid-points of the income ranges presented as answer categories in the questionnaires[8]. The mean household income was the highest (R$1903) in 2007 and the lowest (R$1458) in 2009; the mean was significantly higher in 2007 than in 2008 and 2009. However, the median household income was higher (R$1250) in 2009 and 2007 than in 2008. Comparing to the 2010 census, the mean mid-point income in 2009 is closer to the average monthly income for rural households (R$1,134) rather than urban households (R$3,240) in Belém.[9]

Table 4. Mean household income (using mid-points to represent income categories)

Household income Year	Total N	Missing	Mean	Median	Maximum	Minimum	Standard Deviation
2006	715	715	-	-	-	-	-
2007	653	42	1903	1250	5250	250	1638
2008	408	16	1596	750	5250	250	1593
2009	859	15	1458	1250	5250	250	1193

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[8] These statistics are not presented for 2006 because income was elicited in only 4 different categories that year, making it less informative to calculate statistics based on mid-points of the income ranges

[9] (1) the 2010 Census considered 0.9% of Belém's population to be rural, probably including mostly poorer peri-urban areas, and (2) the Real:USD exchange rate was 0.56 in 2009 vs. 0.58 in 2010.

Product frequencies

The first question in the survey instrument asked "Which forest products do you use?" The respondents were able to freely list up to eight (ten in 2006) products. In many cases, they listed products that were not actually from the forest. Among the responses, I identified and coded an enormous variety of products, 193 in total, including some general categories such as medicinal plants. Including all individual products, the total number of different products cited by consumers was close to 250 (including forest and agricultural products). The table below presents the ten products mentioned by the greatest number of consumers each year.

Table 5. The most common products mentioned by year

| Year | 2006 | 2007 | 2008 | 2009 |
Rank	Product	Product	Product	Product
1	cupuaçu	cupuaçu	banana	banana
2	açai	banana	cupuaçu	cupuaçu
3	banana	bacuri	bacuri	açai
4	bacuri	açai	pupunha	orange
5	orange	melon	orange	melon
6	mango	pupunha	brazil nut	apple
7	apple	orange	açai	pupunha
8	pupunha	uxi	melon	bacuri
9	avocado	brazil nut	uxi	mango
10	brazil nut	pineapple	avocado	avocado

The ten most frequently mentioned products across the years include six non-timber forest products: cupuacu, acai, bacuri, pupunha, uxi and Brazil nut (Table 5). Except for Brazil nut, all of these are fruits produced by trees. The rest (banana, orange, mango, apple, pineapple and avocado) are all non-timber tree products (NTTPs) but most (or all) production is from cultivated trees in orchards or plantations. In addition, melon is in the list in 2007 through 2009 and it is an agricultural product. In 2006, five out of ten products are NTFPs, in 2007 six out of ten, in 2008 again six out of ten and in 2009 four out of the ten most commonly cited products are NTFPs.

These survey results suggest which are the most popular or most commonly consumed non-timber forest products in Belém. They also provide insight on consumer knowledge. Table 6 shows the number and proportion of forest products (including NTFPs and wood products) mentioned by consumers interviewed in each year and in each market type. In 2006, 45% of all the "forest products" mentioned by people who were interviewed in supermarkets were from the forest. The corresponding number for neighborhood markets was 57% and for Ver-o-peso, 62%. In 2007, 48% of the "forest products" mentioned by people who were interviewed in supermarkets were from the forest. The same number for neighborhood markets was 46% and for Ver-o-peso, 40%. In 2008, results for the people who were interviewed in supermarkets are not available. However, 46% of the products mentioned by people interviewed in neighborhood markets and 55% of products mentioned in Ver-o-peso were NTFPs. In 2009, 40% of the products mentioned in interviews conducted both in supermarkets and in neighborhood markets were NTFPs, and 48% of products mentioned in the Ver-o-peso were NTFPs. This suggests that there is limited understanding of forest production, especially among consumers shopping in supermarkets. Many consumers think of tree products, including some that are not native to the Amazon, when asked about forest products. Consumers in the Ver-o-Peso in general listed more products from the forest when asked about their consumption of forest products.

Table 6. Proportion of NTFPs mentioned by year and market type

Year	Place of interview	Proportion of forest products out of all products listed (%)	Number of forest products mentioned
2006	Supermarket	45	293
	Neighborhood markets	57	968
	Ver-o-peso	62	135
2007	Supermarket	48	187
	Neighborhood market	46	281
	Ver-o-peso	40	66
2008	Supermarket	n/a	n/a
	Neighborhood markets	46	366
	Ver-o-peso	55	121
2009	Supermarket	40	203
	Neighborhood markets	40	507
	Ver-o-peso	48	91

Perishability

Many of the most commonly cited NTFPs are perishable (See Appendix F). This is an important factor in NTFP markets, because a reliable supply of electricity is required for ice production or refrigeration to prevent spoilage of perishable products produced far from markets (Wickens, 1991). All of the NTFPs listed in Table 5 are fruits except for Brazil nut, which means that they are perishable. However, some of those fruits are not as quick to spoil. Because of the thick rind protecting piquia and bacuri, they keep well for 4-5 days,

even though they are normally picked after falling from the tree. Uxi normally falls when it is still green, meaning that it stays good for 5 days (Shanley, et al. 2002).

Focal products

The following tables provide information about the focal products, which could be cited by consumers in response to the first open-ended question or in response to follow-up questions that asked specifically about focal product in 2007, 2008, and 2009. Table 7 shows the proportion of respondents who mentioned each of the focal products each year in the free list question. While bearing in mind that consumers probably listed the products that first came to mind rather than every forest product they consume in response to this question, it is worth noting that the proportions are highest for most of the products in 2006 compared to other years.

Table 7. Proportion (%) of respondents who mentioned focal products by year

Product	2006	2007	2008	2009
açai	40.4%	9.6%	9.8%	17%
andiroba	6.6%	0.9%	1.5%	2.7%
copaíba	3.2%	0.9%	1%	1.5%
castanha	9.9%	4.6%	11%	4%
bacuri	22.4%	11.9%	16.2%	9.7%
piquía	4.2%	2.6%	5.4%	1.4%
uxí	8.1%	4.7%	8.1%	2.2%

As shown in table 8, a much higher percentage of respondents confirmed that they had consumed products specifically asked about. This was recognized after the 2006 survey and thus specific questions about each focal product were included in the questionnaires for 2007

through 2009. The percent of respondents consuming açai has stayed about the same across those three years. The proportion consuming the other six focal products decreased in 2009 compared to 2007 and 2008. There were statistically significant decreases in the consumption of copaiba, andiroba, bacuri piquia and uxi between 2008 and 2009. For all except piquia, the decrease from 2007 to 2009 was also significant.

Table 8. Proportion and count of respondents who say they consume focal products by year

	2007		2008		2009	
Consume açai	84.5%	552	84.8%	346	85.8%	737
Consume andiroba	75.2%	491	74.5%	304	58.8%	505
Consume copaiba	63.8%	416	64.0%	261	47.7%	410
Consume castanha	83.2%	543	86.8%	354	79.0%	679
Consume bacuri	82.4%	537	82.6%	337	74.0%	636
Consume piquia	44.9%	293	53.7%	219	39.9%	343
Consume uxi	66.0%	431	68.6%	280	54.4%	467

Table 9 shows the consumption of focal products by place of interview with pooled survey data from 2007 through 2009. In general, smaller proportions of consumers who shop in supermarkets consume each of the products, compared to consumers who shop in neighborhood markets and the Ver-o-peso. This is particularly the case with piquia and uxi: at least 15% fewer shoppers in supermarkets consumer these, compared to shoppers in neighborhood markets and the Ver-o-peso.

Table 9. Proportion and count of respondents who say they consume focal products by place of interview

	Supermarket		Neighborhood markets		Ver-o-peso	
Consume açai	80.3%	378	87.4%	1076	83.0%	181
Consume andiroba	63.7%	300	68.7%	846	70.6%	154
Consume copaiba	52.9%	249	58.0%	713	57.3%	125
Consume castanha	80.0%	377	82.9%	1021	81.7%	178
Consume bacuri	74.7%	352	79.4%	977	83.0%	181
Consume piquia	32.3%	152	48.2%	593	50.5%	110
Consume uxi	49.0%	231	65.5%	806	64.7%	141

Table 10. Proportion and count of respondents who say they consume focal products by year and place

Year		Supermarket		Neighborhood markets		Ver-o-peso	
2007	Consume açai	78.9%	195	87.4%	299	90.6%	58
	Consume andiroba	68.8%	170	78.7%	269	81.2%	52
	Consume bacuri	78.9%	195	83.9%	286	87.5%	56
	Consume castanha	82.6%	204	83.3%	285	84.4%	54
	Consume copaiba	59.1%	146	67.7%	231	60.9%	39
	Consume piquia	30.4%	75	54.7%	187	48.4%	31
	Consume uxi	52.6%	130	73.4%	251	78.1%	50
2008	Consume açai	0.0%	0	86.9%	284	76.5%	62
	Consume andiroba	0.0%	0	76.1%	249	67.9%	55
	Consume bacuri	0.0%	0	82.6%	270	82.7%	67
	Consume castanha	0.0%	0	87.8%	287	82.7%	67
	Consume copaiba	0.0%	0	66.1%	216	55.6%	45
	Consume piquia	0.0%	0	52.9%	173	56.8%	46
	Consume uxi	0.0%	0	70.9%	232	59.3%	48
2009	Consume açai	81.7%	183	87.7%	493	83.6%	61
	Consume andiroba	58.0%	130	58.4%	328	64.4%	47
	Consume bacuri	70.1%	157	74.9%	421	79.5%	58
	Consume castanha	77.2%	173	79.9%	449	78.1%	57
	Consume copaiba	46.0%	103	47.3%	266	56.2%	41
	Consume piquia	34.4%	77	41.5%	233	45.2%	33
	Consume uxi	45.1%	101	57.5%	323	58.9%	43

Table 10 shows the consumption of focal products by year and place. The proportion of shoppers consuming these products is generally decreasing over the years (with the possible exception of açai). The proportion of shoppers who consume andiroba has decreased the most, varying from a 10% decrease in supermarkets to an almost 20% decrease in neighborhood markets. The other medicinal, copaiba, is also consumed by almost 20% fewer shoppers in neighborhood markets. There is no clear trend in consumption of Brazil nuts. The proportions of shoppers reporting consumption of the other fruits (bacuri, piquia, and

uxi) have generally declined, but mostly in particular locations (bacuri and uxi in Ver-o-peso with about 10% and 19% decline in consumer base, and piquia the most in neighborhood markets with 13% decrease from 2007).

The table below (Table 11) shows how many respondents are familiar with the different focal products. One of the criteria for choosing these focal products for the research was that they are well-known and commonly consumed, and thus it was expected that most people would be familiar with all of these products. Bacuri was not included in 2006, but as it was mentioned many times in the questionnaires in the same year, it was included in the study starting in 2007. About the same proportion of people were asked about each product in each year, except for bacuri in 2008, which appears only once in the database. Most of the people are familiar with the forest products, and there generally are not large differences across the years. One notable difference is that copaiba and piquia have particularly low percentages in 2009 compared to other years.

Table 11. Familiarity with focal products

Product		Year			
		2006	**2007**	**2008**	**2009**
Açai	Respondents familiar with the product	120	84	70	121
		100.0%	92.3%	100.0%	98.4%
Andiroba	Respondents familiar with the product	120	92	63	116
		99.2%	94.8%	96.9%	97.5%
Copaiba	Respondents familiar with the product	114	88	66	107
		93.4%	94.6%	98.5%	89.2%
Brazil nut	Respondents familiar with the product	119	95	68	124
		100.0%	99.0%	100.0%	99.2%
Bacuri	Respondents familiar with the product		87	1	119
			94.6%	100.0%	99.2%
Piquia	Respondents familiar with the product	105	82	60	103
		92.1%	87.2%	88.2%	86.6%
Uxi	Respondents familiar with the product	115	77	66	118
		96.6%	85.6%	97.1%	97.5%

Note: Percentages are proportions of respondents who said they are familiar the focal product they were asked about and numbers are counts of the percentages.

Prices

Price information about the focal products is summarized by year and by two market types: open-air market (including Ver-o-peso) and supermarket.[10] Prices were reported for many different units, increasing the possibility of errors, e.g. several very high prices reported for copaiba and andiroba. In addition, some products are processed and sold in different forms. This is the case with Brazil nut, which may be sold either shelled or in-the-shell. As a result, I do not report prices for Brazil nut. Once responses were converted to common units, the variation in prices was reasonable for acai, piquia, bacuri and uxi. However, there are unfortunately only a few observations for uxi and no observations for bacuri in 2008. All prices are reported in reais, and trends are later compared to inflation rates (Appendix E). As expected, there is more variation in prices in the open-air markets.
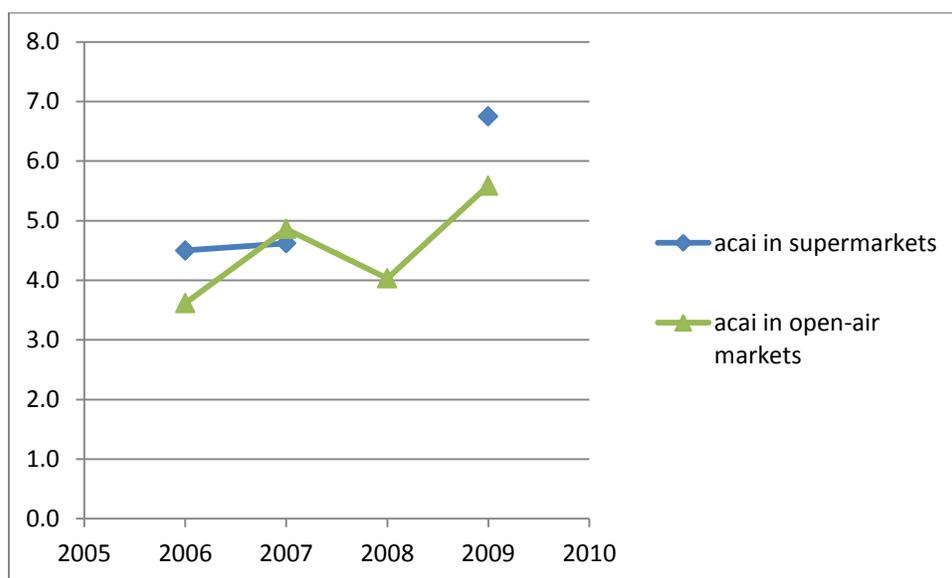
Figure 3. Price trends in açai in open-air markets and in supermarkets

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[10] Ver-o-peso is not reported separately as I had calculated the prices (including a lot of sorting) before making the decision to distinguish the Ver-o-peso from other open-air markets.

Figure 3 shows trends in the mean price of açai both in supermarkets and open-air markets. While the trends are not linear and there are no observations from supermarkets in 2008, it can be noted that (i) prices are increasing in both locations, and (ii) prices tend to be higher in supermarkets.
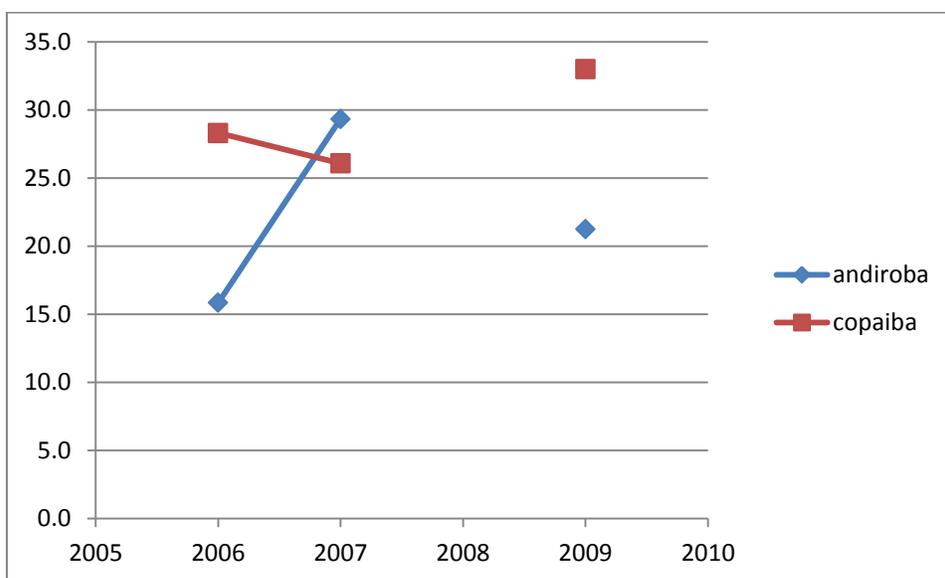
Figure 4. Price trends for copaiba and andiroba in supermarkets
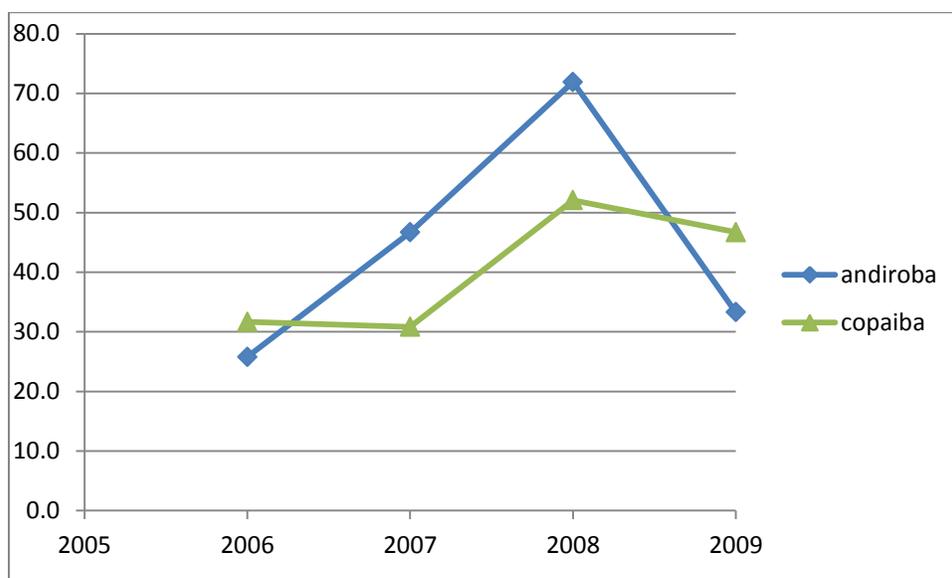
Figure 5. Price trends for andiroba and copaiba in open-air markets

Figures 4 and 5 show mean prices of the medicinal oils copaiba and andiroba in supermarkets and open-air markets. Prices for andiroba have a lot of variation and the price in open-air markets in 2008 is extremely high. This could be because some prices were reported for very small amounts of oil, and I then converted to price per liter. Focusing on prices in the open-air markets, there is first an increasing trend and then a sharp decrease in the price of andiroba. For copaiba, the general trend is a slowly increasing price. Prices are much higher in open-air markets than in supermarkets, although there is so much variation; the mean prices in any given year are not statistically different.
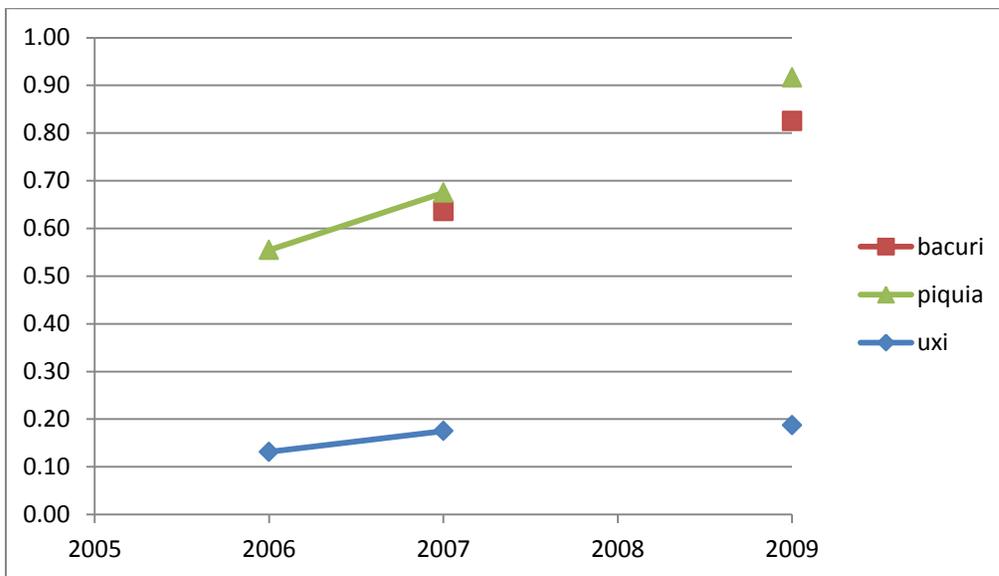
Figure 6. Price trends for piquia, uxi and bacuri in supermarkets
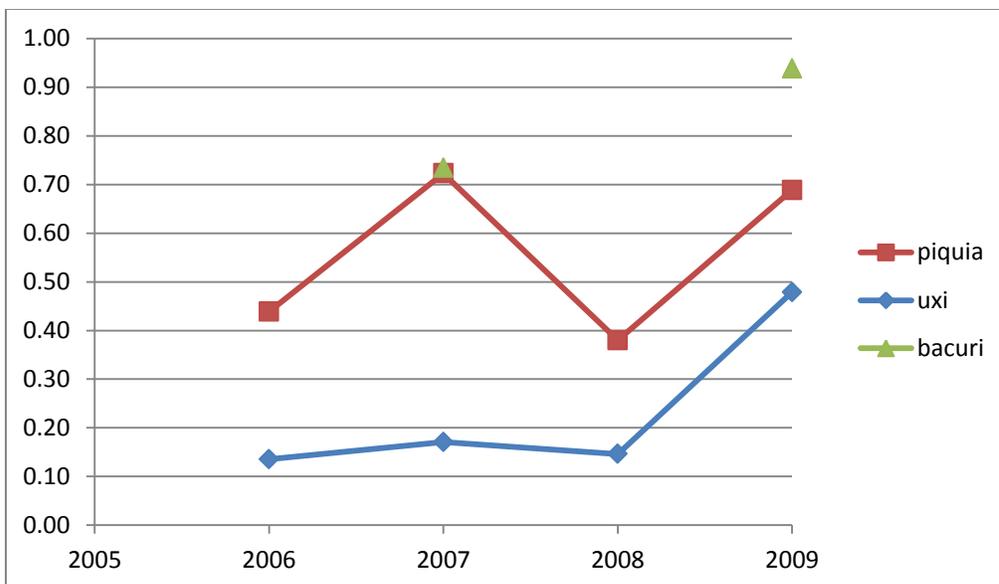
Figure 7. Price trends for piquia, uxi and bacuri in open-air markets

Price trends in supermarkets as well as in open-air markets for the focal fruits bacuri, piquia, and uxi can be seen in figures 6 and 7. Prices are generally higher in 2009 than in 2006, although this does not necessarily reflect a steady upward trend. Piquia's prices are higher in supermarkets, while bacuri's prices are higher in open-air markets.

We compare prices of each product in 2006 and in 2009 in Appendix E (except that we compare prices for bacuri in 2007 and 2009). The rate of change in prices is compared to the mean inflation rate in the time period (Table 12). It can be seen that the rate of change in prices is higher than the inflation rate suggesting increases in the real prices of the products. The high rate of change for uxi in open-air markets is due to some really high price observations (these might be explained by the high variation in prices in open-air markets or another possibility is that they are outliers).

Table 12. Annual rate of change in prices compared to annual inflation rate by product and place

Product	Place	Rate of change in prices	Inflation rate
Açai	Supermarket	15.9%	4.6%
	Open-air market	14.8%	4.6%
Andiroba	Supermarket	8.9%	4.6%
	Open-air market	10.2%	4.6%
Bacuri	Supermarket	9.0%	4.7%
	Open-air market	9.1%	4.7%
Copaiba	Supermarket	13.9%	4.6%
	Open-air market	5.3%	4.6%
Piquia	Supermarket	16.2%	4.6%
	Open-air market	18.7%	4.6%
Uxi	Supermarket	13.5%	4.6%
	Open-air market	50.8%	4.6%

Section II: Cluster Analysis

In this section, I present the results of the market segmentation analysis, identifying groups of consumers with different NTFP consumption (or knowledge) profiles and examining how characteristics vary across these groups.

One reason why I use two step cluster analysis instead of k-means is that "K-Means clustering only supports numeric columns. K-Means clustering ignores model types (nominal and ordinal), and treats all numeric columns as continuous columns." (http://www.jmp.com/support/help/K-Means_Clustering.shtml)

Cluster evaluation

After going through all the different options and comparing them, the best solution seemed to be the ordinal variable solution with five clusters and three variables (edible NTFP, medicinal NTFP and SPENDMOST). The main arguments for this are:

The products that people mentioned are probably products that just quickly came up to their mind, they are not a measure of the exact consumption of NTFPs, and it is also a measure of their knowledge of forest products.

However, it is an indicator of whether they consume many products or only very few/no products.

That is why the count variables might be better to treat as ordinal variables instead of scale variables.

In the scale variable solution, animal NTFP cluster might have been a niche segment, however, there might have been many people who just did not think about animal products

when they were asked about forest products. If they were given a hint, there might have been a lot more people mentioning animal NTFPs.

According to K-means clustering and two-step clustering with ordinal variables animal NTFP and other NTFP did not have a significant importance in creating the clusters so I decided to drop them out of the analysis.

Cluster solution

The final solution uses three variables as inputs:

- **SPENDMOST** = Indicates the NTFP category (edible/medicinal/animal/other) on which the respondent spends the most
- **Edible NTFP** = Number of edible NTFPs the respondent reported in the question "Which forest products do you use?"
- **Medicinal NTFP** = Number of medicinal NTFPs the respondent reported in the question "Which forest products do you use?"

The first two variables are the most important predictors (Figure 8). The procedure identifies five market segments (Figure 9) with a reasonable ratio (1.85) of the largest (650 consumers) to smallest (352 consumers) segments. The solution has silhouette measure of 0.6, which is also considered good. Each of the clusters show a different profile of customers using the variables mentioned.
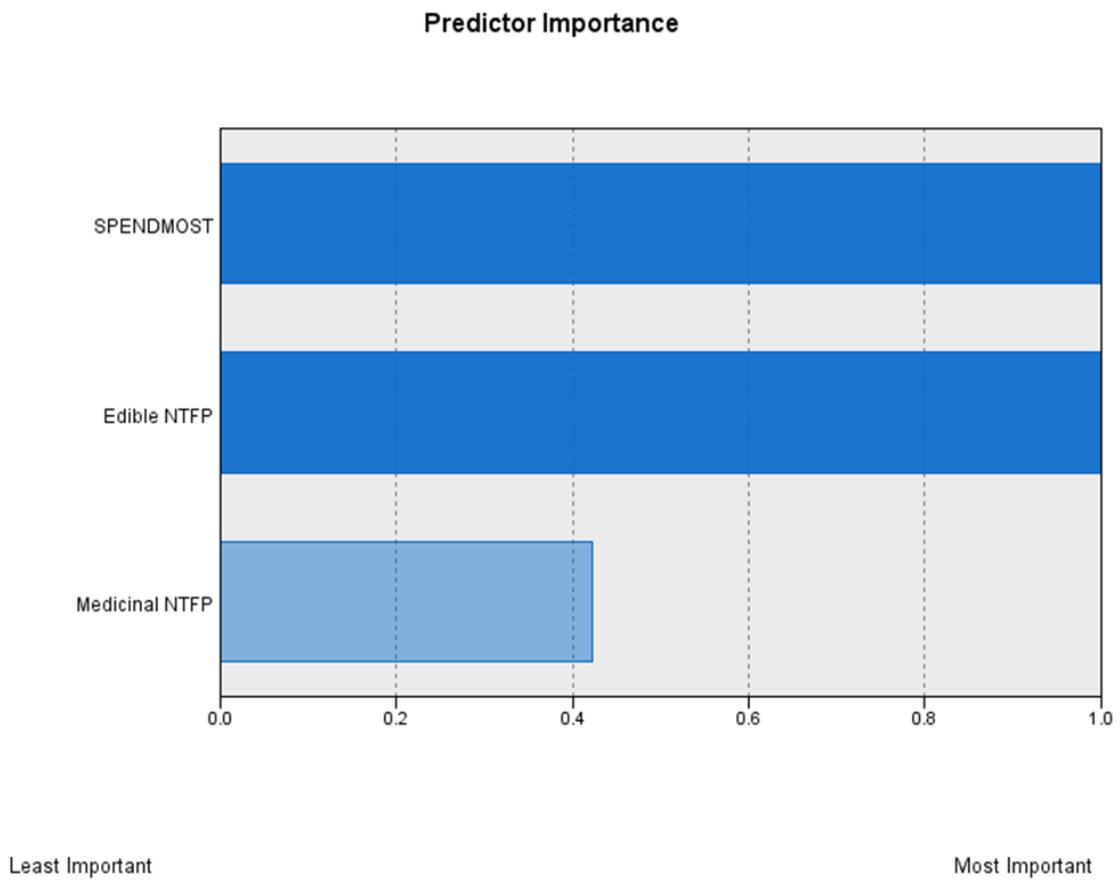
**Figure 8. Predictor importance**
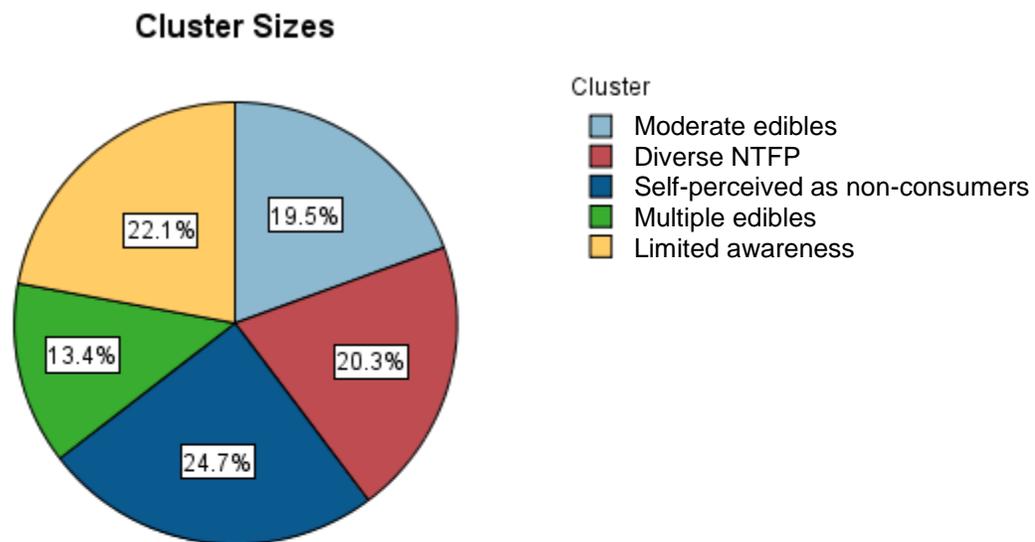
Cluster Sizes

Size of Smallest Cluster	352 (13.4%)
Size of Largest Cluster	650 (24.7%)
Ratio of Sizes: Largest Cluster to Smallest Cluster	1.85

Figure 9. Cluster sizes

Table 13. Cluster description (If percentage not mentioned, it is 100%)

Cluster	Self-perceived as non-consumer	Limited awareness	Diverse consumer	Moderate edibles	Multiple edibles
Size	24.7% (650)	22.1% (582)	20.3% (535)	19.5% (513)	13.4% (352)
Edible NTFP	0	0	1 (38.5%)	2 (52.4%)	3 (58.5%)
SPENDMOST	not NTFP	edible	not NTFP (63%)	edible	edible
Medicinal NTFP	0	0	0 (69.7%)	0	0

Note: Percentages for Size are proportions out of the total sample of respondents and numbers in parentheses are counts of respondents belonging to each cluster. Numbers for Edible NTFP and Medicinal NTFP present the most common amount of these products used in each cluster.

Each of the markets segments has different NTFP consumption behavior as described in the table 13. The following cluster description uses this information as well as the socio-demographic information and other characteristics from table 14. Clusters are described by sample characteristics (gender, place of interview), socio-economic characteristics (higher education, income), and familiarity with the forest (place of birth, whether respondent has entered the forest). In addition, market type information is described according to where the respondents said they normally purchase (Table 15). Also, cluster distribution across years (Table 18) is described and information of the consumption of focal products (Table 16 and 17). In addition, cluster recommendations are provided at the end of each cluster description.

Cluster 1. Self-perceived as non-consumer (24.7%, 650 respondents)

General description of the cluster (Table 13):

The largest market segment identified by the cluster analysis (almost 25% of respondents) includes consumers who do not report buying any NTFPs. Specifically, they report consuming no edible NTFPs and no medicinal NTFPs, and when asked which product they spend the most on, they mentioned a product other than a NTFP.

Socio-economic characteristics (Table 14):

Of the consumers in this cluster, only 17% have tertiary education, and 57% belong to the two lowest income categories, the largest income group being the lowest R$ 0-500. Mid-point income for this cluster is the lowest R$1353. 60% were born in Belém, and 49% say they have entered the forest. Of the consumers interviewed in supermarkets, 26% fall into this cluster, while 24% of those interviewed in neighborhood markets, and 25% in Ver-o-Peso are in this cluster. 66% of the people in this cluster are female.

Market type (Table 15):

Most of the people in this cluster report buying from fairs (as in other clusters). In addition, many people report buying from Ver-o-peso and in other places (other place is some other than the places in the table 15)

Distribution by year (Table 18):

"Self-perceived as non-consumer" cluster was among the two biggest clusters in 2007 through 2009 the proportion varying from 24.9% to 33.7%. However, in 2006 the cluster was the second smallest covering 15.4% of the respondents in that year.

Other characteristics:

Even though this cluster does not report any consumption of NTFPs, it is found out that many of them do consume the focal products, when asked specifically. Consumption of the focal products varies from 33% to 76% depending on the product and only 6% do not consume any of these products (Table 16 and 17). This means

that this cluster does in fact consume NTFPs even though they do not report any. However, it seems that they consume a little bit less than the other clusters, as they report less consumption of the focal products. In addition, this cluster might be unaware of forest products, but also uninterested of these products

Recommendations for the cluster:

This cluster reports the least consumption of NTFPs. More than half (51%) of this cluster has not entered the forest, meaning that they have probably become unfamiliar with the forest. They should be targeted with information campaigns about the health benefits of NTFPs and also about the importance of forests. Especially low-income women should be informed as they cover large proportion (66%) of this cluster.

Cluster 2. Limited awareness consumer (22.1%, 582 respondents)

General description of the cluster (Table 13):

The consumers in this cluster do not list any NTFPs in response to the open-ended question about which products they consume. However 100% of the consumers in this cluster report spending the most on edible NTFPs. While this seems like a contradiction, it is probably due to the questionnaire structure. First the respondents were asked of all the forest products they use. After that they were asked about all of the focal products one by one (in 2007, 2008 and 2009). Next, they were asked which product they spend the most money on. The consumers in this cluster are probably not very aware of NTFPs and therefore could not think of any to list in response to the first question, but the questions about the specific focal products may have reminded them that they do in fact consume forest products. Thus, they report spending the most on these products. (98% of the members in this cluster were interviewed in 2007, 2008 and 2009.Only 2% were interviewed in 2006. 79% of respondents in this cluster reported spending the most on focal products. Most (16%)

of the remaining (21%) reported spending the most on cupuaçu, which is the most common NTFP.)

Socio-economic characteristics (Table 14):

Of the consumers in this cluster, 24% have tertiary education, and 45% belong to the second and the third lowest income categories, the largest income group being the second lowest (501-1000 R$). Mid-point income for this cluster is the second lowest, $R1570. 65% were born in Belém, and 60% say they have entered the forest. Of the consumers interviewed in supermarkets, 26% fall into this cluster, while 21% of those interviewed in neighborhood markets, and 17% in Ver-o-Peso are in this cluster. 57% of the people in this cluster are female.

Market type (Table 15):

The "limited awareness" cluster mainly buys from fairs as the other clusters; however, the percentage is the highest (47.5%) for this cluster. Many people also report buying from Ver-o-peso and other place. It should be noted that the proportion of people who report normally buying from supermarket is the largest (8.1%) in this cluster as well as normally buying from grocery store (4.5%). In addition, the proportion of people who report buying from family members is the lowest (1.7%) in this cluster.

Distribution by year (Table 18):

This cluster is really small (1.7%) in 2006, which is probably due to the questionnaire structure; the focal products were not asked in 2006 (See the general description of the cluster). However, in 2007 to 2009, the "limited awareness" cluster is among the two largest clusters.

Other characteristics:

This cluster report consuming many of the focal products; 40% to 90% report consuming each of the products. Even though this cluster does not report any consumption of NTFPs (except spending the most on edibles), only 2.5% (Table 17) do not report consuming any of the focal products, indicating that they do consume

NTFPs. In fact, 21% (Table 17) of the respondents in this cluster reported consuming all the seven focal products.

Recommendations for the cluster:

This cluster seems to be the least aware of forest products. They should be targeted with information campaigns. A high proportion (65%) of this cluster is born in Belém meaning that the campaigns should be targeted especially for natives of Belém.

Cluster 3. Diverse NTFP consumer (20.3%, 535 respondents)

General description of the cluster (Table 13):

This cluster is characterized by consumption of both medicinal and edible NTFPs and is thus labeled "diverse NTFP" consumption. Specifically, 38.5% of this cluster consumes one edible NTFP (24.5% consume two edibles, 13% three edibles, 4% four edibles, 2% five edibles) and 30.3% consumes medicinal NTFPs (changing from one to five). However, most of them (63%) report spending the most on some product other than NTFPs. Still, 37% do spend the most on NTFPs.

Socio-economic characteristics (Table 14):

Of the consumers in this cluster, 29% have tertiary education, and 44% belong to the two lowest income categories, the largest income group being the second lowest (501-1000 R$). Mid-point income for this cluster is "medium", R$1701. 52% were born in Belém, and 72% say they have entered the forest. Of the consumers interviewed in supermarkets, 19% fall into this cluster, while 21% of those interviewed in neighborhood markets, and 19% in Ver-o-Peso are in this cluster. 62% of the people in this cluster are female.

Market type (Table 15):

Most of the people in this cluster normally buy from fair as in other clusters, however, in this cluster the proportion is a little bit smaller (37.8%). Many people also buy from other place (highest proportion (26.7%) of the clusters), Ver-o-peso

and from street vendor (highest proportion (14.9%) of the clusters). 3.7% of the members in this cluster report normally buying from supermarket and this is the lowest proportion in the clusters.

Distribution by year (Table 18):

Diverse NTFP cluster is the largest in 2006 covering 36% of all the respondents. In other years it is a medium-size cluster covering from 13% to 20% of the respondents.

Other characteristics:

This cluster consumes a lot of the focal products the proportions varying from 54% to 88% depending on the product. This cluster consumes more andiroba (86%, Table 16) and copaiba (75%, Table 16) than the other clusters which is in line with the diverse consumption habits (including medicinals). 39% of the people in this cluster consume all of the focal products which is actually the highest number in all the clusters (Table 17).

Recommendations for the cluster:

This cluster has a "medium" socio-demographic profile and they buy the least from supermarkets and the most in other places. What are these other places? How to reach these consumers as they are buying a lot from some other places? The cluster was the largest in 2006 and decreased to "medium" size cluster in other years. It is the only cluster who report consumption of medicinal NTFPs. I think this cluster would need more investigation in order to find ways to reach them.

Cluster 4. Moderate edible consumer (19.5%, 513 respondents)

General description of the cluster (Table 13):

52.4% of the members in this cluster report consuming two edible NTFPs and the remaining 47.6% report consuming one edible NTFP. (2% report consuming one animal NTFP and 1% other NTFP) 100% spend the most on edible NTFPs.

Socio-economic characteristics (Table 14):

Of the consumers in this cluster, 30% have tertiary education, and 49% belong to the second and the third lowest income categories, the largest income group being the third lowest (1000-1500 R$). Mid-point income for this cluster is R$1852, which is the second highest among the clusters. 59% were born in Belém, and 66% say they have entered the forest. Of the consumers interviewed in supermarkets, 19% fall into this cluster, while 20% of those interviewed in neighborhood markets, and 20% in Ver-o-Peso are in this cluster. 52% of the people in this cluster are female.

Market type (Table 15):

This cluster normally buys from fairs as the other clusters. In addition, many people (20.4%) buy from Ver-o-peso and this is actually the highest proportion in all the clusters. Quite many people (19.2%) report normally buying from other place as well.

Distribution by year (Table 18):

Moderate edible cluster is the second largest (27.2%) cluster in 2006, however in 2007 and 2008 it is among the smallest clusters and 2009 a medium-size cluster.

Other characteristics:

People in this cluster report consuming the focal products varying from 52% to 92%. They report consuming more of the focal fruits and Brazil nut than the "self-perceived as non-consumption" and "limited awareness" clusters, however less than the "diverse consumer" and "Multiple edible" consumer. 28% of the people report consuming all the seven focal products and 23% five of these products (Table 17).

Recommendations for the cluster:

This cluster is consuming edibles, but not as much as high multiple edible consumers and probably less than diverse NTFP consumer. This cluster would need some promotion of NTFPs as well in order to maintain or even increase their consumption. This cluster probably understands some of the health benefits of NTFPs, however, these characteristics could be emphasized in advertisement campaigns.

Cluster 5. Multiple edible consumer (13.4%, 352 respondents)

General description of the cluster (Table 13):

The consumers in this cluster consume several different edible NTFPs, with most (58.5%), reporting three products, but also significant amount (29%) report consuming four products and some (9%) report five products and the rest few percent even more. They also report spending the most on edible NTFPs, and they do not report consuming other types of NTFPs.

Socio-economic characteristics (Table 14):

Of the consumers in this cluster, 40% have tertiary education, and 38% belong to the two second and the third lowest income categories, the largest income group being the second lowest (501-1000 R$). However, it should be noted that the highest income group (more than 4500 R$) is the highest in this cluster (15%) compared to other clusters. Mid-point income for this cluster is R$2078, which is the highest among the clusters. 51% were born in Belém, and 79% say they have entered the forest. Of the consumers interviewed in supermarkets, 10% fall into this cluster, while 13% of those interviewed in neighborhood markets, and 19% in Ver-o-Peso are in this cluster. 53% of the people in this cluster are female.

Market type (Table 15):

"Multiple edibles" cluster normally buys from fairs as the other clusters; however, the proportion (39.9%) is the second lowest among the clusters. Many of them report buying from other place (25.9%), Ver-o-peso (17.8%) and street vendor (12.2%) as well. The proportion (4.8%) buying from family member is the largest in this cluster and the proportion (1.7%) buying from grocery store is the smallest among the clusters.

Distribution by year (Table 18):

This cluster is the smallest of all the clusters and it has the biggest share of clusters in 2006 covering 19.7% of all the clusters being the third largest cluster. However, in other years it is among the smallest clusters and 2009 it covers only 8.7% of all the clusters being the smallest one.

Other characteristics:

Most of the people in this cluster consume the focal products, the proportions varying from 60% to 94%. This cluster consumes more of all the edible focal products than the other clusters which is in line with the consumption habits previously mentioned.

Recommendations for the cluster:

This cluster has the highest socio-demographic profile and seems to be the most familiar with the forest and forest products. However, this cluster should be targeted well in order to keep it viable, as it is the smallest cluster and its size decreased from 19.7% to 8.7% from all the clusters. This cluster has similar characteristics (high income, highly educated, aware of nature etc.) than the consumers in the international green markets. They could be targeted with advertisement campaigns emphasizing the "super food" elements of many NTFPs.

Table 14. Cluster description with socio-demographics

Variable	Self-perceived as non-consumer	Limited awareness	Diverse NTFP	Moderate edible	Multiple edible
Gender	65.6%	57.3%	61.9%	52.0%	53.1%
Place of birth (Belem)	59.7%	65.1%	51.6%	58.8%	51.3%
Tertiary education (yes)	17.4%	23.7%	29.4%	29.5%	40.4%
Have you entered the forest? (yes)	49.2%	59.8%	72.1%	66.2%	78.7%
Income category					
0-500 R$	30.3%	19.9%	19.9%	9.4%	12.9%
501-1000 R$	26.2%	24.1%	23.6%	22.6%	20.6%
1000-1500 R$	14.7%	21.0%	15.4%	26.8%	17.7%
1001-2000 R$	8.6%	10.9%	10.1%	9.4%	9.6%
2001-3000 R$	8.0%	10.6%	16.5%	14.2%	15.3%
3000-4500 R$	6.1%	5.8%	4.9%	8.4%	9.1%
more than 4500 R$	6.1%	7.7%	9.7%	9.4%	14.8%

Table 15. Where people most often buy by clusters

Place	Self-perceived as non-consumer	Limited awareness	Diverse consumer	Moderate edibles	Multiple edibles
Supermarket	5.7%	8.1%	3.7%	5.9%	4.5%
Grocery store	3.3%	4.5%	2.5%	3.8%	1.7%
Ver-o-peso	17.8%	18.0%	19.9%	20.4%	17.8%
Fair	45.9%	47.5%	37.8%	41.9%	39.9%
Family member	3.4%	1.7%	2.1%	3.0%	4.8%
Street vendor	9.8%	9.6%	14.9%	10.3%	12.2%
Other place	19.7%	14.6%	26.7%	19.2%	25.9%

Table 15 presents the number of respondents and the proportion of respondents in each cluster who most often buy from different outlets. In all clusters, the largest fraction of people report that they most often buy from neighborhood open-air fairs or markets, perhaps due to their convenience. Ver-o-Peso shoppers make up the largest fractions of "Diverse" and "Moderate edible" consumer, consistent with the greater availability of medicinal and other non-edible NTFPs in the Ver-o-Peso. However, I would have assumed "Multiple edibles" segment to have a higher percentage. People who report that they usually buy NTFPs in supermarkets make up the largest fraction of "Limited awareness" cluster, which appears to be the least aware of NTFPs. This could reflect both lack of information about NTFPs in supermarkets and a tendency for less-informed or less-aware consumers to purchase NTFPs in supermarkets.

Table 16. Consumption of focal products by clusters

Consume	Self-perceived as non-consumer	Limited awareness	Diverse NTFP	Moderate edibles	Multiple edibles
Açai	74.6%	90.2%	82.0%	90.6%	94.3%
Andiroba	62.8%	64.9%	85.6%	62.1%	73.5%
Bacuri	66.2%	80.2%	83.1%	82.8%	94.3%
Castanha	75.9%	81.6%	88.1%	84.3%	88.6%
Copaiba	50.7%	51.8%	75.2%	51.7%	67.6%
Piquia	33.3%	41.2%	53.6%	51.7%	59.7%
Uxi	54.6%	59.8%	69.1%	60.8%	73.5%

Table 17. Number of focal products consumed by clusters

Number of products	Self-perceived as non-consumer	Limited awareness	Diverse NTFP consumer	Moderate edibles	Multiple edibles
0	5.9%	2.5%	2.2%	2.5%	1.9%
1	5.4%	2.3%	1.4%	2.5%	0.5%
2	8.7%	7.7%	3.6%	4.4%	1.9%
3	13.1%	13.0%	8.3%	13.8%	4.7%
4	22.8%	19.5%	14.7%	17.2%	13.7%
5	16.7%	18.1%	13.3%	22.9%	23.2%
6	10.2%	14.4%	17.6%	8.8%	16.6%
7	17.2%	22.6%	38.8%	27.9%	37.4%
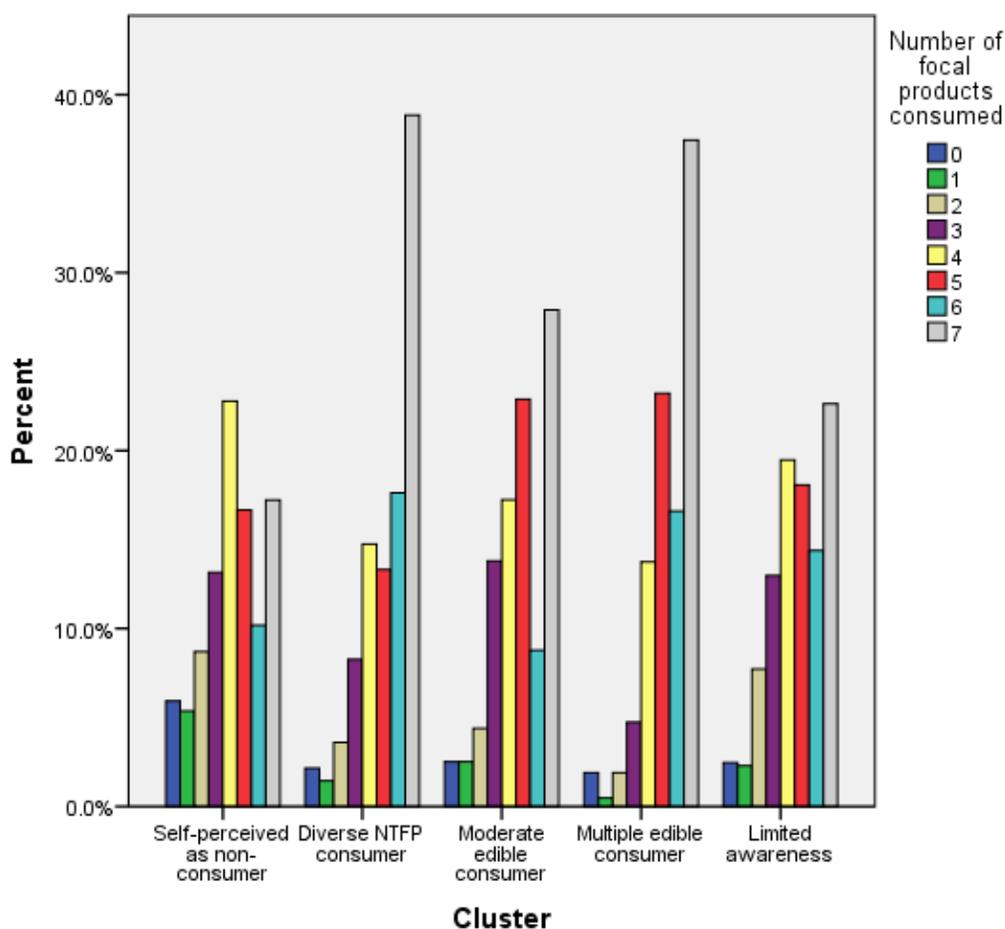
Figure 11. The proportion (%) of focal products consumed by each cluster

Figure 11 presents the same information than table 17, just that it is in a visual form. In the "Self-perceived as non-consumer of NTFPs" the proportion of people who consume one or none of the focal products is the largest compared to other clusters, as expected. However, many people in this cluster do still report consumption of the focal products, suggesting that they may just not think of these products as coming from the forest. Consumers in the "Limited awareness" also report consuming focal products, with the largest percent reporting consumption of all seven products and only a small percentage consuming one or none of the products. This is consistent with our interpretation of this cluster as consumers with limited

awareness of NTFPs. In all of the other clusters, the largest sub-group consumes all seven focal products. In the clusters labeled "Diverse NTFP consumer" and "High consumption of edible NTFPs," the sub-group that consumes all seven focal products is notably larger than the other sub-groups, confirming our interpretation of these clusters as significant NTFP consumers.

Table 18. Cluster distribution by year

Cluster	Year			
	2006	**2007**	**2008**	**2009**
Self-perceived as non-consumer	15.4%	33.7%	26.0%	24.9%
Limited awareness	1.7%	32.3%	22.4%	31.2%
Diverse NTFPs	36.0%	13.2%	20.4%	12.7%
Moderate edibles	27.2%	10.9%	13.8%	22.4%
Multiple edibles	19.7%	10.0%	17.4%	8.7%

The size of each cluster varies across years, with the most even distribution in 2008 (Table 18). Most notably, there are very few (only 1.7%) consumers in the "Limited awareness" cluster in 2006, perhaps because consumers who would have been placed in this cluster in other years were clustered with the non-NTFP consumers in 2006 due to the questionnaire structure. However, in fact, the largest clusters in 2006 were "diverse NTFPs" and "primarily edible NTFPs," suggesting more consumers interviewed in that year did in fact consume NTFPs. Self-perceived as non-consumer and limited awareness- clusters are the largest clusters in 2007, 2008 and 2009.

Discussion

The literature suggests several reasons why regional markets for NTFPs are important; these include facilitating income generation from NTFPs for both producers and traders, and the role of NTFPs in healthy diets and in medical care for consumers. The literature also identifies some barriers to realizing those potential benefits of regional markets for NTFPs, including product perishability, lack of credit, and production constraints related to forest degradation and over-exploitation. In this section, I consider how my results can elaborate the discussion about the potential benefits and the barriers to regional markets for NTFPs by providing a detailed understanding of the consumption patterns and consumers in one of the largest markets in the Amazon basin.

Importance of NTFPs

Previous studies report that NTFPs are culturally important for urban and rural consumers in developing countries. In our study area, medicinal plants are reported to be especially important for the poor (Shanley and Luz, 2003). Potentially, NTFPs could help mitigate the negative effects of the "nutrition transition," as they are easily available and culturally familiar sources of fruits, vegetables, whole grain and animal products (Popkin et al., 2008, Johns & Sthapit, 2004).

This study confirms that NTFPs are important for the people of Bélem. Many people report consuming the focal products (percentages varying from 40-90% depending on the products); for example, in three years (2007, 2008, 2009) of the survey, around 85% of respondents said that they consume açai. The importance of NTFPs is also shown in the answers to the question "Which forest products do you use?" People listed a wide variety of different products. However, the market segmentation shows that consumption of a variety of NTFPs is actually associated with higher socio-economic status. Thus, while medicinal NTFPs may be important relative to modern medicines for the poor, it seems the poor are not necessarily the primary consumers of medicinal plants in Belém. Specifically, the "self-perceived as

non-consumer" and "limited awareness" clusters are characterized by lower income and education. Individuals in these clusters do not report any consumption of medicinal NTFPs in the open-end question. They do report consuming copaiba and andiroba when they are asked about them specifically, but still they report consuming them less than other clusters. However, these individuals also seem to have less knowledge about NTFPs and they may not report everything they consume.

Knowledge about forest products

We have hypothesized that consumers in regional (compared to international) markets will have greater familiarity and cultural affinity with NTFPs that might cause more stable demand as was described (Table 1) by Shackleton et al. (2007). While this may be true, our results suggest that the cultural importance might not be based on knowledge of the forest or understanding that NTFPs come from the forest, as people in Bélem seem to be living a highly urbanized life. Many individuals said they have not entered the forest (2007: 35%, 2008: 36% and 2009: 42%). Therefore, we cannot assume that people would know which products come from the forest. In addition, only about half of the products that people free-listed as forest products, were actually forest products.

Many of the products people listed were agricultural or cultivated products. In addition, people who did not report any NTFPs when asked an open-ended question still indicated that they do consume some of the focal products. Taking these two points into consideration, we could conclude that responses to the question "Which forest products do you use?" are not only information about the consumption of forest products, but also a reflection of consumers' knowledge about forest products. This is shown in the cluster analysis, where the second largest segment was the "limited awareness" segment presenting people with low economic status, the highest percentage of people born in Belém (65%), with large proportion of people not having entered the forest (40%) and with quite low number of educated people (24%).

Perishability

Most of the non-timber forest products that people mentioned (See Appendix F) were edible NTFPs; such as cupuacu, which was mentioned by the greatest number of people in all four years. The majority of the most popular products are fruits, which is a challenge to producers and traders of NTFPs, as fruits are perishable. Attention should be paid to the storing and transporting these products, as noted by Belcher and Schreckenberg (2007). In addition, if the products travel long distances, more attention should be paid to the processing of the products. Processing could improve the hygiene and increase the profits of the products. However, many people prefer to consume the products (especially fruits) fresh, as noted in by Barbosa de Lima (2011).

Demand and supply (forest degradation, production and cultivation, and prices)

Consumption of NTFPs could change over time as a result of changes in consumer preferences, consumer income, changes in the supply of NTFPs, and/or competing demand for NTFPs from the South of Brazil or export markets. In their study of fruit consumption in Sao Paolo, Brazil, Martins et al. (2007) note that consumer behavior was directly related to the social and economic changes in the country in the preceding years.

The literature discusses the possible increasing demand for some NTFPs in urban centers (Padoch et al. 2008). This is not supported in our study, since smaller proportions of respondents reported NTFP consumption across the years. NTFPs were free-listed the most frequently in the first year, and in decreasing amounts each subsequent year. Consumption of focal products is decreasing as well. Decreasing consumption might be due to general socio-economic changes in the area, which are possible effects of the recession. It seems that income decreases in 2008 and 2009. In addition, larger phenomena might affect the consumption as well. The nutrition transition is an example of such phenomena. Lower consumption and knowledge of forest products is associated with low income groups, suggesting that dietary changes could be happening in these groups. Another possible reason

for decreased consumption is decreased availability due to forest degradation and over-exploitation. Decreased availability appears to be related to increasing prices.

Açai seems to be an exception, since, according to the focal product question in 2007, 2008 and 2009, its consumption has been high and has remained steady or even increased, despite its increase in worldwide popularity.

Brondizio (2004) confirms the increasing demand of açai in national and international markets, and mentions that the production of açai increased sixfold in the time period from 1980- 2000. Açai has been heavily promoted for its health and energy characteristics in the media. Brondizio (2004) notes that the nature of the international and regional markets is different; in regional markets, açai is considered as staple food, and in export markets, it is a fashion food.

Forest degradation and over exploitation are widely noted concerns related to NTFPs. How does it affect the future availability of these important NTFPs? The literature addresses this availability concern, especially regarding the medicinal oils copaiba and andiroba, and one of the fruits, uxi.

The fact that açai has been heavily promoted and that it is mainly coming from managed agroforestry systems (Brondizio, 2004), gives us some insights for the other products as well. Even though my results do not directly support that forest degradation is occurring, the decreasing consumption might be a consequence of said degradation. In addition, respondents' unfamiliarity with the forest and forest products might lead to increasing forest degradation as people might not understand the importance of forests and the products available. Different kinds of management or cultivation plans should also be considered for the other focal products and other threatened NTFPs from natural forests.

Cultivation and management options would also ease the general challenge of production and collection in the trade of NTFPs. If more of the production came from agroforestry systems, for example, the collection would not be so complex and time consuming. However, there is

competition of land in Belém, and not all production should come from cultivated stands. Instead, some production could come from managed stands and some from natural forests; this strategy would decrease the pressure on forests without competing too much with other land uses.

Açai, Brazil nut, copaiba and andiroba are facing the challenge of increasing international demand. There should be management plans for these species in order to guarantee the availability for both international and regional markets. However, the local fruits uxi, piquia and bacuri do not have international markets (according to my understanding), but still face problems of decreased availability, especially uxi. These species should be promoted and the production should be made sustainable as these fruits are really important for the locals.

The literature mentions the relatively low prices for many NTFPs especially if the collection and transportation costs are high, as they often are. The price information in our study indicates an increasing trend. However, the price information is not totally reliable as it might include some outliers and there is a lot of variation in the prices especially for copaiba and andiroba. Still, it seems that the prices are increasing as the rate of change in prices is higher than the average inflation rate. The increasing prices might be caused by decreased availability. The decreased availability might be due to increasing harvesting costs, which the NTFP literature is suggesting as well. The increasing harvesting costs instead might be caused by deforestation, forest fires, or unsustainable harvesting.

Consumer segments

One objective of my research questions was to find consumer segments in the regional markets for NTFPs in Belém. Five different segments were found and it was quite surprising that the "self-perceived as non-consumer" and "limited awareness" segments were so large (together 47% of the sample) indicating both lack of knowledge and low consumption of NTFPs. In 2006, the "limited awareness" cluster was very small, which is probably due to the questionnaire structure. In 2006, the "limited awareness" individuals were probably categorized in to the "self-perceived as non-consumer" segment. Actually the "Self-

perceived as non-consumer" and "limited awareness" clusters covered only 17% of the respondents in 2006, compared to 66% in 2007, 49% in 2008 and 56% in 2009. Individuals in the "Self-perceived as non-consumer" segment also present some limited awareness about NTFPs because many of them do report consuming the focal products (50% or more report consuming the focal products, except uxi, which 33% reported consuming). The "limited awareness" group had the largest proportion of people who were born in Belem (65%) versus others (50-60%). This might suggest that there is an increasing group of urbanized (having little or no contact with forests) poor people in Belém who are consuming fewer NTFPs than the wealthier people (who were more often born in other places).

Supermarkets versus fairs

Big international supermarkets are penetrating more markets in developing countries including Brazil. For example, in the main shopping places in city of Sao Paulo, the open-air markets were still the main shopping places for fruits and vegetables in the time period of early 1980s to late 1990s. However, the sales in open-air markets had decreased by 35% while the sales in supermarkets had increased by 432% (Martins et al., 2007).

The main shopping places for NTFPs in Belém are various open-air markets, Ver-o-peso being the largest one. NTFPs are purchased from supermarkets as well. According to our results, most (38-48%) of the people reported regularly buying from neighborhood markets while only 3 to 7 % reported buying from supermarkets. Our study reveals that the open-air markets are still very popular. However, the amount of individuals reporting that they normally buy from supermarkets increased from 3% in 2006 to 7% in 2009. This might suggest that supermarkets are overtaking more markets.

It should be also noted that the knowledge about forest products seems to be lower in supermarkets than in other places. This is worth considering, if supermarkets are penetrating more markets in Belém as well.

Lack of credit

One of the challenges in the trade of regional markets for NTFPs is the lack of credit. According to my results, it seems that the sellers and producers should be informed of the processing possibilities and give possibilities to have new technology. The most popular NTFPs are fruits. As mentioned, perishability is a challenge with these products and therefore processing is one option. However, producers and sellers need credit options in order to make improvements. Government should take some actions in informing (training) and offering credit. In addition, producers would need information as well as training considering the different management and cultivation methods including credit possibilities for new technologies.

International versus regional markets

In my literature review I emphasized the importance of regional markets compared to international markets. Regional markets are important, however, they face many challenges as confirmed in this study. I think the different consumer segments in these markets should be considered in order to keep the markets viable. These segments should be targeted with different kinds of information and advertisement campaigns as described in the cluster recommendations. In addition, microfinance and other similar solutions are necessary for the producers and sellers in order for them to address the challenges in the regional markets for NTFPs.

Study limitations

Some of the limitations of this study were the partly inconsistent data across the years, the possible differences with the interviewing techniques in different years and the fact that many people were involved in the data processing. Some of the socio-demographic variables and focal product questions were not asked in 2006 or were asked in different way, which caused the exclusion of that year in some parts of the analysis. In addition, there is some uncertainty whether the interviewers gave some hints to the respondents when asking about

the forest products people consume in the year 2006. In that year, the amounts of forest products mentioned were more (especially the focal products) than in other years. However, I used other questions as well in my analysis (ex. focal product questions) which excluded 2006 and therefore excluded the possible effects of the methodology differences making the results more reliable. Data processing has been a big part of my work and there is the possibility that some errors have happened. However, I had the original data and processed data in my hand and I was able to confirm some "issues" from the original data.

One more limitation is the nature of the main question ("Which forest products do you use?") in the cluster analysis. The exact trends in consumption are difficult to analyze, as this question measures both consumption and knowledge about forest products. In addition, the specific question about the focal products does not tell us the amounts of consumed.

For someone who is considering similar study, I recommend to be careful with all the different files and naming them accordingly. In addition, I would suggest forming a bigger picture of the topic before running into data analysis and once in a while remembering that picture.

Conclusions

This work provides a wide description of the market for non-timber forest products in Bélem as well as characterizes the consumers in urban markets, which is unique in the research of NTFPs. Describing the market in general, but still focusing on the focal products allowed a critical view of the general trends in the knowledge and consumption of NTFPs, confirmed by investigating focal products. The information provided is useful when trying to get answers to the more wide issues such as forest degradation, nutrition transition, effects of urbanization to consumption habits and changes in market structures (international supermarkets penetrating the market).

Some general points:

(1) This study confirms that there are a wide variety of NTFPs consumed in Belém, with in total 48, 35, 34, and 47 different NTFPs reported by consumers in the years 2006 through 2009;

(2) Likewise, this study confirms that a large proportion of the population of Belém consumes NTFPs, with at least 96% reporting consumption of at least one of the focal research products 2007 through 2009; fruits are clearly the most commonly consumed NTFPs, but still, at least 68% reporting consumption of at least one of the focal medicinal products in 2007 through 2009;

(3) However, the fact that many people consume NTFPs does not mean that everyone consumes NTFPs or that everyone is aware of consuming them; the cluster analysis identified significant market segments that either do not consider themselves as consumers or are not aware that they consume NTFPs: 47% of the sample in fell into either the "self-perceived as non-consumer or "limited awareness" clusters; these clusters generally had people with less education and lower income, more natives of Belém and females as well as people who have not entered the forest.

(4) In addition, there seems to be decreasing trend in consumption of NTFPs which is indicated by decreasing amount of NTFPs mentioned across the years and decreasing amounts of focal products mentioned.

Non-timber forest products are shown to be important for the urban consumers in Bélem, however, their consumption seems to be decreasing. The decreased consumption might be due to several reasons. First one is forest degradation, which is affecting to the availability of many non-timber forest products and this way might affect to the consumption as there is less supply. Forest degradation and the decreased availability instead might increase the prices, which seems to be happening in our study area as well. Prices are the second reason affecting consumption; increasing prices correspond to decreases in consumption, especially among poor people unable to afford certain products anymore. A third reason to explain decreased consumption is related to the wider phenomena, "nutrition transition". As people are moving from diverse traditional diets to more simple diets with a lot of fat and energy, they probably consume less NTFPs. This seems to be more common among poor people. Lastly, the fourth reason to the decreased consumption could be lack of knowledge about forest products (which emerged from our study).

The general trend towards unfamiliarity with forests and forest products are increasing, especially among the poor and therefore policy recommendations include the need to inform people of the variety of products (fruits, nuts, fibers) and the health benefits related to many non-timber forest products as suggested also by Johns and Sthapit (2004). For example, NGOs could launch campaigns for low-income natives of Belém in order to increase awareness (as well as pride and interest) and possibly develop markets of regional products. There is one example of such campaign/program in the state of Amazonas where they incorporate regional products into school meals (http://www.ads.am.gov.br/pagina.php?cod=7).

In order to increase the consumption of NTFPs, attention should be paid to the different markets segments found in the study including the "multiple edibles" cluster. These segments

should be targeted with different information and advertisement campaigns characterized in the cluster analysis part. In addition, government should improve the knowledge and conditions of producers and sellers (of NTFPs) in order for them to target these segments and to meet all the challenges in the trade. Different agroforestry and other cultivation and management options should be considered with the aim to guarantee the future availability of these products and to make the production and collection process easier. Governments should make management plans especially for those NTFPs that are threatened and are facing both regional and international demand. In order to address the perishability challenge, producers and sellers should be trained about different processing options. When meeting the challenges in the trade of NTFPs, access to credit plays an important role. Microfinance or similar options should be offered to producers and sellers of NTFPs in order to meet the challenges of production and processing. Government or NGOs should also offer training in marketing and increase the awareness of the health benefits of NTFPs among the sellers so that they could target their products better.

There is a need for further research. This study shows declining trends in consumption of NTFPs, especially among the poor. However, the consumption and knowledge (or lack of) about forest products was combined together and it would be good to investigate the exact consumption (not affected by the knowledge) of the urban poor as well as the wealthier groups in developing countries. The specific consumer preferences could be investigated more; the importance of price in relation to other product characteristics and consumer preferences about buying locations. What makes the open-air markets so popular and are there trends in moving more to supermarkets among the consumers? In addition, consumer preferences on processed products (dried for example) should be investigated.

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APPENDICES

Appendix A – Age distribution of respondents

Year: 2006
Mean = 41.36
Std. Dev. = 16.287
N = 714

Year: 2007
Mean = 43.07
Std. Dev. = 15.243
N = 647

Year: 2008
Mean = 41.8
Std. Dev. = 14.599
N = 406

Year: 2009
Mean = 36.27
Std. Dev. = 12.822
N = 848
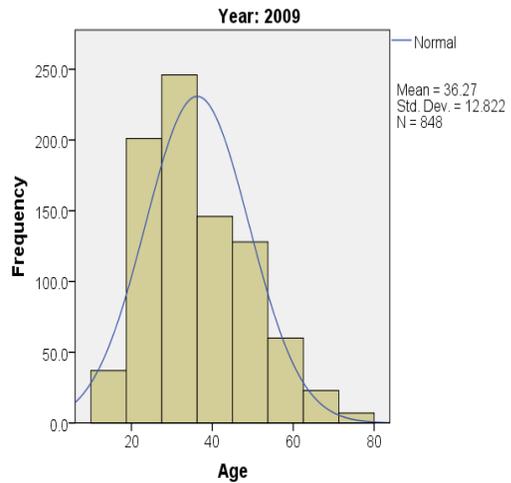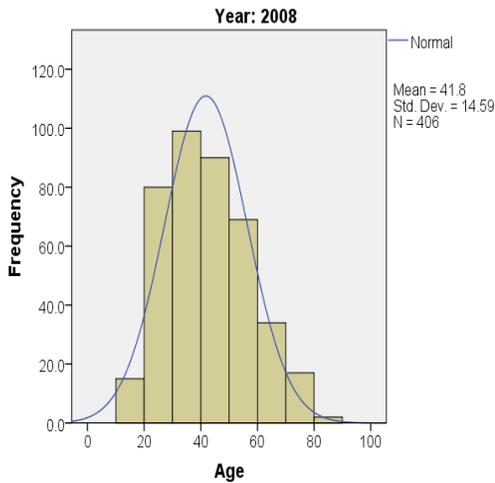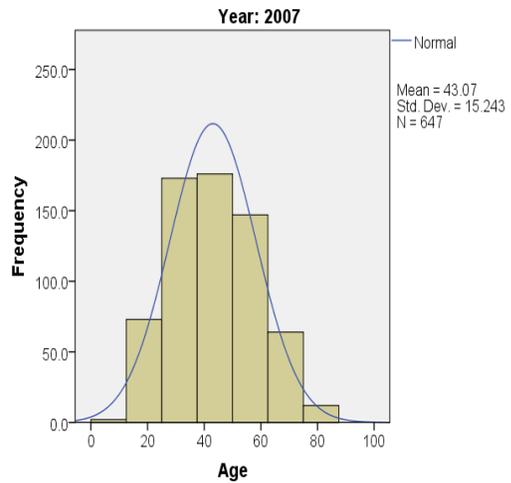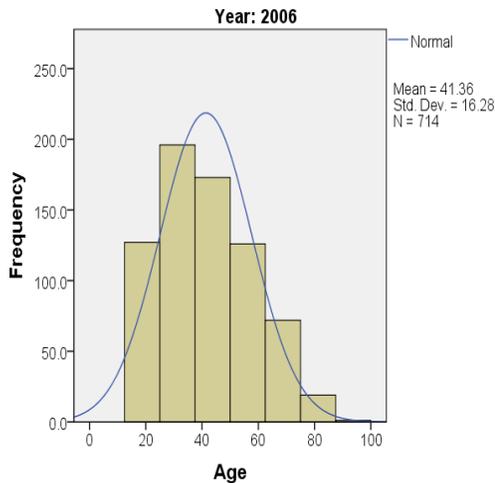
Appendix B – Family size distribution

Year: 2006

Year: 2007

Year: 2008

Year: 2009
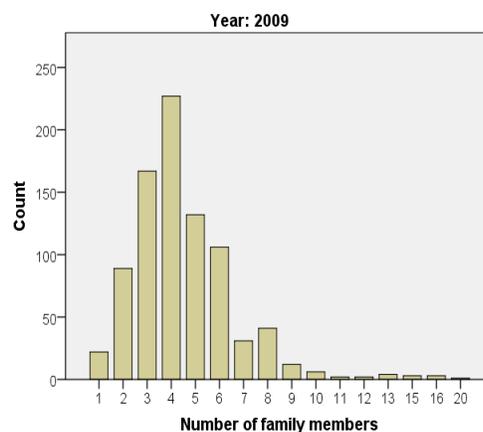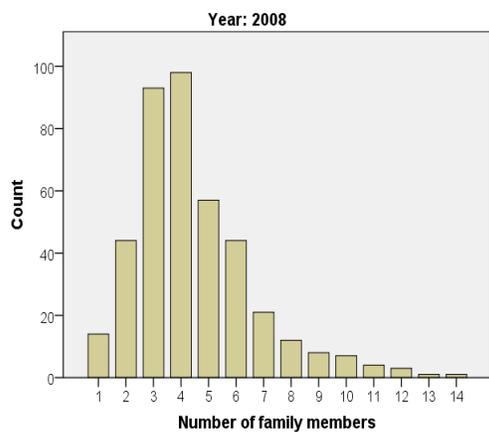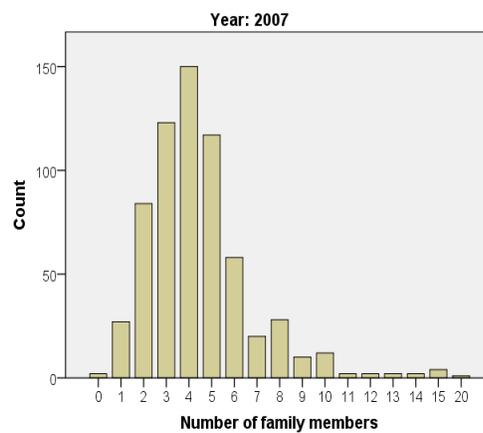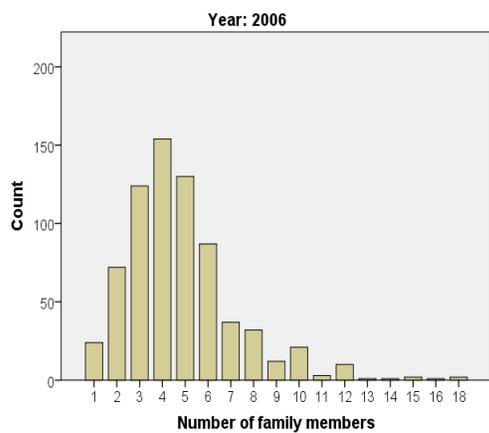
Appendix C – Distribution of number of children

Year: 2006

Mean = 1.26
Std. Dev. = 1.405
N = 691

Year: 2007

Mean = 1.01
Std. Dev. = 1.211
N = 604

Year: 2008

Mean = 1.01
Std. Dev. = 1.154
N = 407

Year: 2009

Mean = 1.06
Std. Dev. = 1.202
N = 848
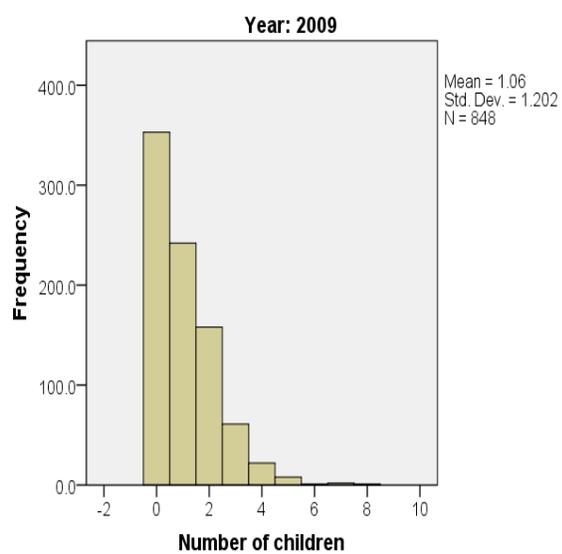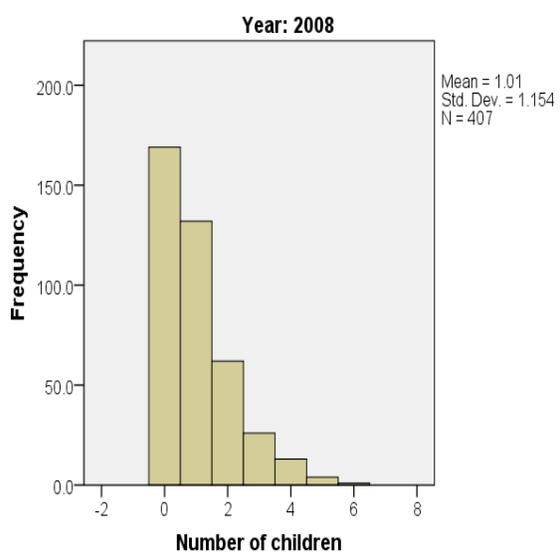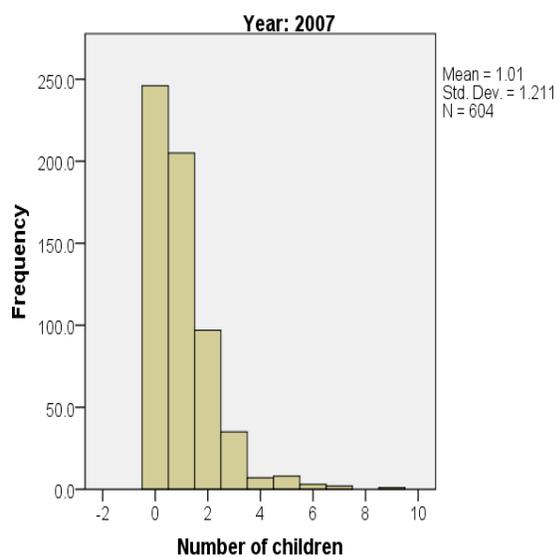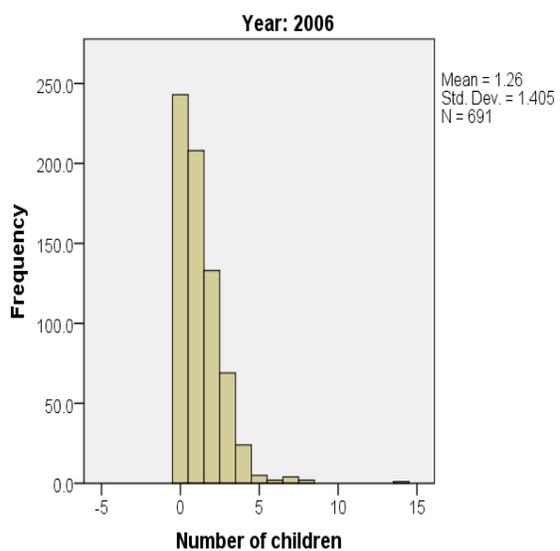
Appendix D – Income distribution by year
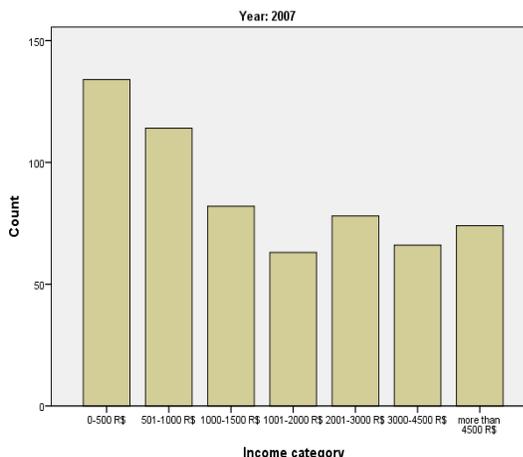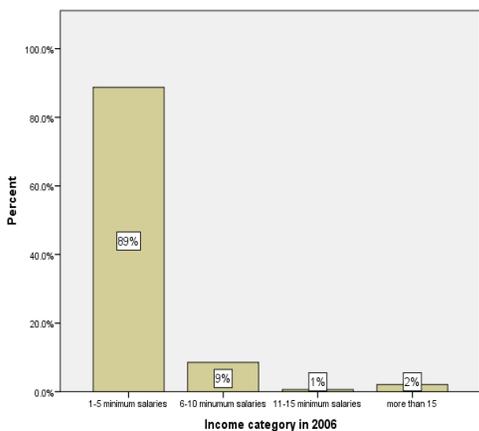
Exchange rate: 1 Brazilian Real = 0.4739 US dollars (3/15/2007 Source: oanda.com)
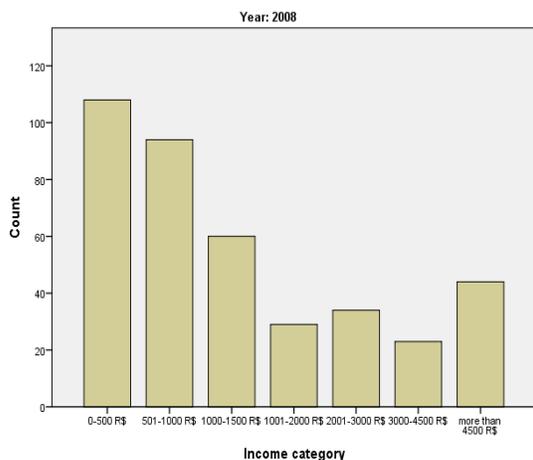
Exchange rate: 1 Brazilian Real = 0.5880 US dollars (3/15/2008 Source: oanda.com)
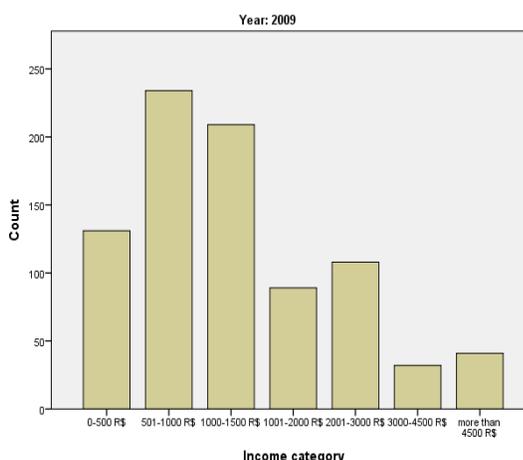
Exchange rate: 1 Brazilian Real = 0.4328 US dollars (3/15/2009 Source: oanda.com)

Appendix E – Prices for focal products

Table 19. Prices for acai, andiroba and copaiba

| Product	Year	Place	Mean	Median	St.dev.	Min	Max	# observations
Acai	2006	Open-air market	3.62	3.00	1.23	2.00	8.00	81
		Supermarket	4.50	4.00	1.79	3.00	10.00	23
	2007	Open-air market	4.86	5.00	1.91	2.00	10.00	44
		Supermarket	4.62	5.00	1.69	2.00	10.00	21
	2008	Open-air market	4.03	4.00	1.41	2.00	8.00	31
		Supermarket						
	2009	Open-air market	5.59	5.00	1.71	3.00	10.00	77
		Supermarket	6.75	7.50	2.20	3.00	12.00	22
Andiroba	2006	Open-air market	25.79	20.00	26.47	1.20	120.00	60
		Supermarket	15.85	10.00	11.69	5.00	40.00	10
	2007	Open-air market	46.68	20.00	57.34	5.00	250.00	22
		Supermarket	29.33	15.00	33.18	6.00	100.00	9
	2008	Open-air market	71.89	23.00	119.62	3.00	500.00	18
		Supermarket						
	2009	Open-air market	33.29	20.00	35.91	4.00	175.00	32
		Supermarket	21.25	17.50	16.67	8.00	60.00	8
Copaiba	2006	Open-air market	31.65	20.00	36.02	0.50	175.00	34
		Supermarket	28.31	17.50	27.74	5.00	100.00	12
	2007	Open-air market	30.83	20.00	24.76	5.00	100.00	13
		Supermarket	26.07	24.29	14.14	5.00	42.86	6
	2008	Open-air market	52.06	24.00	70.94	5.00	250.00	17
		Supermarket						
	2009	Open-air market	46.70	45.00	32.15	5.00	100.00	24
		Supermarket	33.00	30.00	23.79	8.00	60.00	6

Table 20. Prices for bacuri, piquia and uxi (prices are at current reais)

Product	Year	Place	Mean	Median	St.dev.	Min	Max	# observations
Bacuri	2006	Open-air market						
		Supermarket						
	2007	Open-air market	0.73	0.67	0.48	0.17	2.00	19
		Supermarket	0.64	0.60	0.29	0.25	1.00	5
	2008	Open-air market						
		Supermarket						
	2009	Open-air market	0.94	0.90	0.47	0.16	2.00	55
		Supermarket	0.83	0.73	0.36	0.30	2.00	18
Piquia	2006	Open-air market	0.44	0.40	0.19	0.10	1.00	27
		Supermarket	0.55	0.50	0.32	0.21	1.00	7
	2007	Open-air market	0.72	0.50	0.18	0.25	2.67	11
		Supermarket	0.68	0.68	0.27	0.33	1.00	4
	2008	Open-air market	0.38	0.20	0.35	0.20	1.00	5
		Supermarket						
	2009	Open-air market	0.69	0.50	0.44	0.20	2.00	29
		Supermarket	0.92	0.75	0.49	0.50	1.50	6
Uxi	2006	Open-air market	0.14	0.10	0.06	0.05	0.33	52
		Supermarket	0.13	0.10	0.05	0.10	0.20	9
	2007	Open-air market	0.17	0.10	0.18	0.08	1.00	26
		Supermarket	0.18	0.18	0.11	0.10	0.25	2
	2008	Open-air market	0.15	0.10	0.10	0.10	0.50	18
		Supermarket						
	2009	Open-air market	0.48	0.20	0.66	0.10	2.00	36
		Supermarket	0.19	0.20	0.04	0.10	0.20	8

Appendix F – Top10 non-timber forest products

The most common non-timber forest products in different location in different years

The following tables (21 to 23) list the ten most common products in each year and each market type (supermarket, neighborhood fair and Ver-o-peso). In addition, the product category and whether the product is perishable are reported.

Table 21. Top10 NTFPs in supermarkets markets by year

Top10 NTFPs in supermarkets									
	2006			**2007**			**2009**		
Rank	**Product**	**Category**	**Perishable**	**Product**	**Category**	**Perishable**	**Product**	**Category**	**Perishability**
1	cupuacu	Edible	Yes	cupuacu	Edible	Yes	cupuacu	Edible	Yes
2	acai	Edible	Yes	acai	Edible	Yes	acai	Edible	Yes
3	bacuri	Edible	Yes	bacuri	Edible	Yes	pupunha	Edible	Yes
4	pupunha	Edilble	Yes	pupunha	Edible	Yes	bacuri	Edible	Yes
5	brazil nut	Edible	No	brazil nut	Edible	No	muruci	Edible	Yes
6	andiroba	Medicinal	No	tapereba	Edible	Yes	tapereba	Edible	Yes
7	cashew	Edible	No	jamba	Edible	Yes	andiroba	Medicinal	No
8	uxi	Edible	Yes	uxi	Edible	Yes	brazil nut	Edible	No
9	palmito	Edible	No	graviola	Edible	Yes	biriba	Edible	Yes
10	tapereba	Edible	Yes	piquia	Edible	Yes	graviola	Edible	Yes

Table 22. Top10 NTFPs in neighborhood markets by year

Top10 NTFPs in neighborhood markets

Rank	2006			2007			2008			2009		
	Product	Category	Perishable	Product	Category	Perishable	Product	Category	Perishable	Product	Category	Perishable
1	cupuacu	Edible	Yes	cupuacu	Edible	Yes	cupuacu	Edible	Yes	cupuacu	Edible	Yes
2	acai	Edible	Yes	acai	Edible	Yes	bacuri	Edible	Yes	acai	Edible	Yes
3	bacuri	Edible	Yes	bacuri	Edible	Yes	pupunha	Edible	Yes	bacuri	Edible	Yes
4	pupunha	Edible	Yes	pupunha	Edible	Yes	brazil nut	Edible	No	pupunha	Edible	Yes
5	brazil nut	Edible	No	brazil nut	Edible	No	acai	Edible	Yes	brazil nut	Edible	No
6	uxi	Edible	Yes	uxi	Edible	Yes	uxi	Edible	Yes	biriba	Edible	Yes
7	andiroba	Medicinal	No	piquia	Edible	Yes	piquia	Edible	Yes	uxi	Edible	Yes
8	tapereba	Edible	Yes	muruci	Edible	Yes	muruci	Edible	Yes	muruci	Edible	Yes
9	muruci	Edible	Yes	tapereba	Edible	Yes	biriba	Edible	Yes	andiroba	Medicinal	No
10	piquia	Edible	Yes	becaba	Edible	Yes	mari	Edible	Yes	fish	Animal	Yes

Table 23. Top10 NTFPs in Ver-o-peso by year

Top10 NTFPs in Ver-o-peso

Rank	2006			2007			2008			2009		
	Product	Category	Perishable	Product	Category	Perishable	Product	Category	Perishable	Product	Category	Perishable
1	cupuacu	Edible	Yes	cupuacu	Edible	Yes	cupuacu	Edible	Yes	cupuacu	Edible	Yes
2	acai	Edible	Yes	bacuri	Edible	Yes	bacuri	Edible	Yes	acai	Edible	Yes
3	bacuri	Edible	Yes	pupunha	Edible	Yes	acai	Edible	Yes	pupunha	Edible	Yes
4	pupunha	Edible	Yes	acai	Edible	Yes	pupunha	Edible	Yes	bacuri	Edible	Yes
5	brazil nut	Edible	No	piquia	Edible	Yes	brazil nut	Edible	No	brazil nut	Edible	No
6	uxi	Edible	Yes	uxi	Edible	Yes	uxi	Edible	Yes	copaiba	Medicinal	No
7	muruci	Edible	Yes	muruci	Edible	Yes	tapereba	Edible	Yes	andiroba	Medicinal	No
8	piquia	Edible	Yes	tapereba	Edible	Yes	piquia	Edible	Yes	uxi	Edible	Yes
9	andiroba	Medicinal	No	biriba	Edible	Yes	muruci	Edible	Yes	honey	Edible	No
10	graviola	Edible	Yes	jamba	Edible	Yes	tucuma	Edible	Yes	piquia	Edible	Yes