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Traditional knowledge of tree "bleeding" in brazil nut tree (*Bertholletia excelsa*) management

Conhecimento tradicional da "sangria" no manejo da castanheira-do-brasil (*Bertholletia excelsa*)

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ABSTRACT

The Brazil nut or Amazonian-nut tree (*Bertholletia excelsa*) is native to the Amazon with a long history of management by traditional populations (or extractivists). "Bleeding" is a management practice in which the trunk is cut to expel resin and bolster fruit production. The objective of this paper was to describe how this practice is perceived and performed by extractivists in three extractive reserves (*reservas extrativistas* or *Resex*): Rio Ouro Preto (in the state of Rondônia, RO), Rio Cautário (RO), and Chico Mendes (in Acre, AC). First, semi-structured interviews were conducted in nine communities, sampling at least 30% of the families in each community. Subsequently, to understand variation in how this practice is performed, we used snowball sampling and applied another questionnaire to extractivists who executed bleeding. Almost all extractivists knew of the practice, but not all engaged in it. Many extractivists believed that expelling the resin prevents fruit abortion and improves production.

Keywords: traditional populations; extractive reserves; Amazonian-nut.

RESUMO

A castanheira-do-brasil ou castanheira-da-amazônia (*Bertholletia excelsa*) é uma árvore nativa da Amazônia com longo histórico de manejo pelas populações tradicionais (ou extrativistas). A "sangria" é uma prática de manejo, em que cortes são feitos no tronco para expelir resina e favorecer a produção de frutos. O objetivo deste trabalho foi descrever como essa prática é percebida e realizada pelos extrativistas de três reservas extrativistas (Resex): Rio Ouro Preto (RO), Rio Cautário (RO) e Chico Mendes (AC). Primeiramente, foram realizadas entrevistas semiestruturadas em nove comunidades, amostrando pelo menos 30% das famílias de cada comunidade. Em seguida, para entender como essa prática é percebida pelos extrativistas, foi utilizada a metodologia "bola de neve" e aplicado outro questionário com os extrativistas que realizavam a sangria. Praticamente todos os extrativistas reconheciam a prática, mas nem todos a executavam. Muitos extrativistas acreditavam que expelindo a resina evita o aborto dos frutos e melhora a produção.

Palavras-chave: populações tradicionais; reservas extrativistas; castanha-da-amazônia.

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Introduction

Traditional peoples and recognition of their territories in the Amazon

The Amazon forest, the largest tropical forest on the planet, with its high biodiversity, has been inhabited by Indigenous peoples for thousands of years. These communities were able to adapt to the forest conditions, surviving and preserving the environment and local biodiversity (Homma et al., 2020; Martins and Guedes, 2020). In addition to Indigenous populations, traditional peoples have also used forest resources over the years and developed profound local knowledge and sustainable practices for forest management and use of forest products for food, medicine, and income generation (Levis et al., 2018; Loch et al., 2023; Galvão et al., 2024).

The joint struggle of Indigenous peoples and traditional communities to remain in their territories gained visibility and greater recognition in the 1980s with the Alliance of Forest Peoples, a movement that joined rubber tappers, Brazil nut gatherers, and Indigenous communities in defense of the forest and the land they inhabited for generations (Silva, 2019; Domingues and Sauer, 2023). This process led to the establishment of legal mechanisms to guarantee their rights. In possession of their territories, these groups demonstrated that it was possible to live in the forests, utilizing sustainable management practices (Silva, 2019).

In 2007, Decree No. 6,040 defined traditional peoples and communities as culturally distinct groups that self-identify and have their own ways of organizing socially, acquiring knowledge, and developing practices and innovations to manage forest resources (Brasil, 2007). These practices are transmitted through tradition and used in their sociocultural and economic reproduction (Reyes-García et al., 2019; Renck et al., 2023; Albuquerque et al., 2024).

Thus, legal provisions recognize the right of traditional peoples and communities to remain and exercise autonomy in their territories, including the use of extant biodiversity and self-knowledge acquired throughout their lifetimes (Silva, 2019; Pereira et al., 2021). Traditional knowledge is defined as "the set of knowledge and know-how about the natural and supernatural world, orally transmitted from generation to generation" (Diegues, 2000, 2019). This knowledge derives from observations and informal experiments mediated through cultural practices, strengthening community relationships and the various forms of communal life (Alcantara and Sampaio, 2017).

Management of Brazil nut trees by traditional populations

The Brazil nut tree (also termed "Amazonian-nut" in contemporary parlance) is a native species of the Amazon, belonging to the *Lecythidaceae* family. This large-sized tree has widespread distribution in upland forests throughout the Amazon basin and the Guianas (Mori and Prance, 1990). The distribution of Brazil nut trees and the formation of native Brazil nut groves result from forest management practices of Amazonian peoples over hundreds of years, initiated by Indigenous communities when they first inhabited these forests (Wadt et al., 2008; Scoles, 2011; Scoles and Gribel, 2015; Caetano Andrade et al., 2019). Brazil nut is a cornerstone of conservation, being one of the few seeds collected in mature native forests by traditional populations using low-impact harvesting techniques (Guariguata et al., 2017). Harvesting is typically a family activity, with everyone collecting the fruits and seeds together in Brazil nut-rich forests during the harvest season (Bethonico et al., 2023).

Brazil nut collection requires knowing the forest, species ecological characteristics, and having the manual skills and artisanal tools to open the fruits (Waldhoff and Souza, 2023). Studies indicate that the collection method used by extractivists (traditional people who live in extractive reserves) does not put stand maintenance at risk (Wadt et al., 2008). Inadvertent seed dispersal during the collection period actually can contribute to the formation of new stands near the trails used during the harvest (Ribeiro et al., 2014; Caetano Andrade et al., 2019). Additionally, liana removal from Brazil nut trees can increase fruit production significantly and may prevent mortality in heavily infested trees (Kainer et al., 2014). "Bleeding" (making shallow incisions into the bark) is another practice adopted by extractivists to enhance fruit production (Duchelle et al., 2014), although there are no systematic studies on its effects on Brazil nut trees. Studies to examine the effects of superficial cuts made to other species have been carried out on rubber trees (*Hevea brasiliensis*) (Sari et al., 2024) and pine species (*Pinus* spp.) (Lema et al., 2024). These cutting practices are intended to promote nut production, preserve the species, and improve the quality of life of extractivists (Waldhoff and Souza, 2023).

Given the socio-economic importance of the Brazil nut tree and the uncertainties among extractivists regarding *B. excelsa* tree bleeding in the management of Brazil nut groves, this article aimed to analyze how this practice is perceived and performed by extractivists. We specifically addressed the following questions: 1. How is the traditional practice of *B. excelsa* tree bleeding carried out by extractivists? 2. What are their perceptions of the effectiveness of this practice?

Materials and Methods

Study sites

The research was conducted in the Rio Ouro Preto Extractive Reserve (ROP Resex) and the Rio Cautário Extractive Reserve (RC Resex), both located in the state of Rondônia, and in the Chico Mendes Extractive Reserve (CM Resex), in the state of Acre (Figure 1). Preliminary research dictated the choice of these reserves where the authors have worked for decades. Long-term observations and informal discussions with extractivists indicated that there were variations in the way bleeding was implemented and in the perceived harms and effectiveness of this practice on individual *B. excelsa* trees. We then set out to systematically examine these initially identified differences between states and extractive reserves.

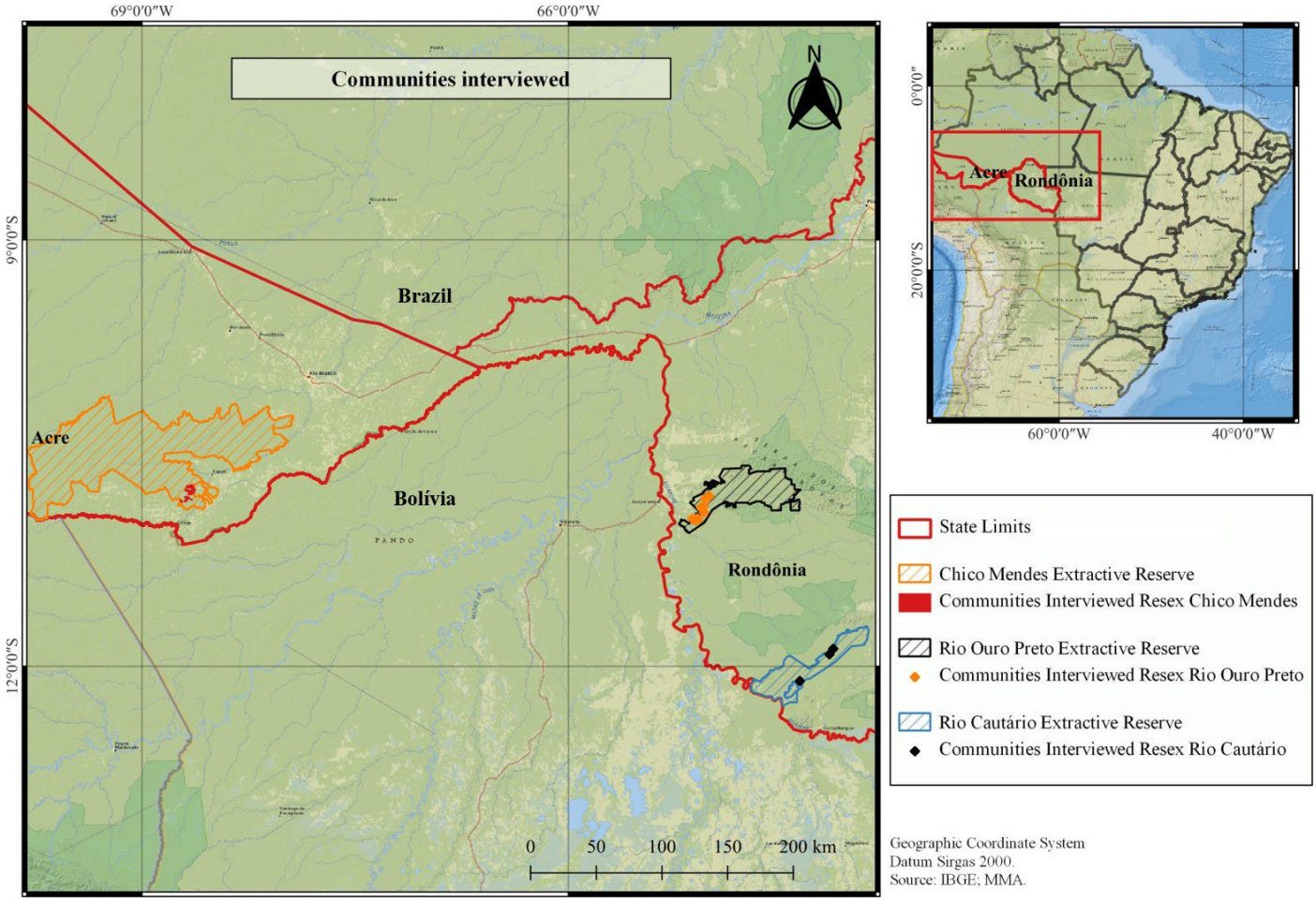

Figure 1 – Location map of the Rio Ouro Preto and Rio Cautário Extractive Reserves in Rondônia and the Chico Mendes Reserve in Acre, along with approximate locations of the interviewed communities.
Source: Gomes (2023).

Extractive reserves result from a more than 10-year historical process of struggle for land and natural resources by Amazonian rubber tappers. According to Decree No. 98.897 of 1990, extractive reserves are defined as "territorial spaces intended for the self-sustainable exploitation and conservation of renewable natural resources by extractive populations". The decree characterized extractive populations as "rubber tappers, Brazil nut gatherers, and riverine communities, mostly settled in the Northern region of the country, living harmoniously with the ecosystem, extracting in an economically viable and ecologically sustainable manner what the system itself produces" (Allegretti, 2008, p. 48).

Located in the municipalities of Guajará-Mirim and Nova Mamoré, the ROP Resex was created in 1990 with an approximate area of 204,583 hectares and has 187 resident families, as per the Chico Mendes Institute for Biodiversity Conservation (ICMBio) 2017 registration. ROP Resex includes "beneficiary" families, those who live in and depend economically on the reserve, and "user" families, those who do not need to live within the reserve to exploit its resources, classified into three categories: temporary, resident, and occasional users. This is the only reserve in our study that has both beneficiary and user families. The other reserves only have beneficiary families.

Located in the municipalities of Guajará-Mirim and Costa Marques, the RC Resex is a protected area managed by different jurisdictions (Federal and State). The area under State jurisdiction was created in 1995 with an approximate area of 146,400 hectares, while the Federal area was created in 2001 with an approximate area of 75,124 hectares. However, there is no difference in the environmental and social dynamics between these two reserves (Brasil, 2017). In the last ICMBio survey, 110 beneficiary families were registered.

The CM Resex was created in 1990 with an approximate area of 970,570 hectares and covers the municipalities of Assis Brasil, Brasiléia, Capixaba, Xapuri, Sena Madureira, and Rio Branco in Acre. A 2018 survey registered approximately 3,300 families (*Associação dos Moradores e Produtores da Reserva Extrativista Chico Mendes em Brasiléia e Epitaciolândia*, AMOPREBE).

The ROP and RC Resex are in the same region and count with family ties among the residents. On the other hand, the CM Resex is in a distinctly different geographical region and there are no family relationships between its extractivists and those from Rondônia. However, all extractivists are descended from rubber tappers, originating from the Northeast region during the Amazon rubber boom.

Data collection

The research was carried out in two stages: first, to understand how the extractivists perceived the traditional practice of bleeding on *B. excelsa* trees; and second, to register how the extractivists performed the bleeding and perceived its effects on the Brazil nut trees. Data collection took place between February 2022 and May 2023.

Extractivists' perceptions of bleeding

Three communities were selected from each reserve for data collection. Community leaders answered a survey to determine the number of families in each community and questionnaires were randomly applied to at least 30% of these families (Table 1).

At this stage, the lead author applied semi-structured interviews (Albuquerque et al., 2010), using questionnaires prepared with open and closed questions about knowledge and performance in bleeding. The interviews were carried out individually with one representative per family.

Extractivists' performance of the bleeding practice

In this second stage, additional interviews were undertaken, but only with families that practiced bleeding. Following the snowball sampling methodology (Bernard, 2002), each interviewee indicated another person who performed bleeding. We halted interviews when the names indicated began to be repeated. Family members, usually couples, participated in the interviews because they often engaged in Brazil nut collection together.

Table 1 – Number of interviewees per community in each extractive reserve researched.

Extractive reserve	Community	Number of families per community	Number of families interviewed	Percentage interviewed (%)
Rio Ouro Preto, RO	• Pompeu	44	16	36
	• Nova Esperança	39	12	31
	• Nova Colônia	29	9	31
Rio Cautário, RO	• Laranjal	29	10	34
	• Canidé	16	9	56
	• Ilha (Jatobá)	35	13	37
Chico Mendes, AC	• Verdes Florestas	37	11	30
	• Wilson Pinheiro	40	13	32
	• Boa Esperança	24	8	33
Total			101	

Participant observation frequently accompanied by a family member was also conducted to identify and record, through photographs, how the practice was employed. These observations were made in the forest, which permitted more detailed observations and established a familiar and comfortable setting for participants, reducing researcher-participant power differentials.

The questionnaire was applied in open interviews with nine questions that addressed aspects of how and why bleeding was done, who it was learned from, how the cut was made, what size, quantity, and depth of the tree trunk cut, what tools were used, whether there was one best time of the year to perform bleeding, and how the trees to be bled were chosen. It was also asked about the extractivists' perceptions of the effect of bleeding on fruit production and tree vitality and whether the resin had any functionality.

To analyze extractivists' perceptions regarding the effect of bleeding on Brazil nut trees, structured questions were developed on a 5-point Likert scale (Bermudes et al., 2016), in which the respondents indicated their degree of agreement or disagreement with the options presented. To quantify the extractivists' perceptions regarding the effect of bleeding on Brazil nut tree production, a classification based on Brandalise et al. (2009) was developed.

Research ethics

Permissions were granted by the Ethics Committees of the Federal University of Rondônia (CEP No. 4,058,806), the Chico Mendes Institute for Biodiversity Conservation (SISBIO: Rio Ouro Preto No. 74319-1; Chico Mendes No. 75431-1; Cautário No. 74559-1), and by the State Secretariat for Environmental Development of the State of Rondônia, Coordination of Protected area (No. 0028.154665/2020-86).

In all reserves, prior contact was made with the community leaders to introduce the study objectives and request authorization for interviews and data collection, with the signing of the Provider's Prior and Informed Consent Form and research registration in the National System for the Management of Genetic Heritage and Associated Traditional Knowledge (SisGen No. AC4EBB4). A Free and Informed Consent Form was signed by each interviewee before conducting the interview.

Results

Extractivists' perceptions of the bleeding practice

We interviewed 101 extractivists, 93 men and 8 women, ranging in age from 21 to 83. All were extractivists descended from rubber tappers. Over 96% knew about the bleeding practice; however, not all applied the technique to Brazil nut trees.

In the RC and CM Resex, most extractivists still practiced the technique, whereas in the ROP Resex, only half of the respondents engaged in it (Figure 2). Considering all 101 respondents, 21 (21%) did not practice bleeding. When asked why they did not do so, 48% of this group answered that it was because they did not know how to perform the technique.

Some mentioned lack of interest, saw no effect, or did not have their own nut stands to implement practices of their choosing. A small minority stated that they did not bleed because their nut grove was already productive, and they did not perceive the need. In addition to the 21 respondents who did not practice bleeding, seven extractivists had previously bled their trees but stopped because they perceived no positive results in fruit production.

In the ROP Resex, the mean age of those who did not practice bleeding was 40.5 years (standard deviation±14.3), whereas the mean age of those who practiced bleeding was 63 years (±10.6). The mean age of those who used to practice but stopped was 48 years (±11.3). In the RC Resex, the average age of those who did not engage in the practice was 51 years (±5.7), while for those who practiced bleeding, it was 42 years (±14.6). In this reserve, no extractivist started and then stopped engaging in the practice. In the CM Resex, the average age of those who did not engage in the practice was 58 years (±12.4), while for those who did, it was 49 years (±12.5). The only extractivist among the CM Resex interviewees who started and then stopped the practice was 70 years old.

Extractivists' performance of the bleeding practice

The bleeding practice was characterized by 32 extractivists, including 8 in the CM, 12 in the ROP, and 12 in the RC Resex. All expressed that the purpose of bleeding was to improve fruit production. However, not everyone volunteered to explain how the process occurred on the tree. Of those who did, 44% believed that by expelling the tree resin through the cuts, the fruit remained in the canopy, improving its production, for example, by preventing abortion.

When asked about when they first initiated the practice, the majority (85%) answered that they started bleeding when they began collecting nuts as children, learning from their parents or other extractivists. Of the older individuals aged 65.6 years on average, 9% had learned from their employers during the rubber extraction period. There was a case in which the extractivist learned from researchers during project development, thus initiating the practice recently.

Two types of cuts were most mentioned by extractivists: the "window" and the "thin-cut" (Figure 3). The window type is a square cut with dimensions ranging from 20 by 20 cm (height and width) to 40 by 40 cm, made on the trunk of the Brazil nut tree (Figures 4A and 4B). The thin-cut type is an inclined cut with a length from 20 to 40 cm to allow the resin to flow (Figure 4C).

In the CM Resex, only the thin-cut type was mentioned, whereas in the ROP and RC Resex, both types were cited, with the window type being more commonly used. For 75% of the extractivists interviewed, the cut was made only in the depth of the thick bark, while for others, the cut entered approximately three centimeters into the wood. Regarding the number of cuts on the trunk, it was mentioned that it depended on the size of the Brazil nut tree, with up to four cuts possible for larger trees. Only one extractivist interviewed performed girdling (meaning cuts that extended over the entire trunk circumference) on the trunk of Brazil nut trees. The tool used by most respondents was a machete, with a small axe also being used.

Regarding the period in which bleeding was performed, 56% of the interviewees considered the moon's and sun's positions. They did not perform bleeding during the new moon due to the risk of pest attacks at the cut location that might kill the tree. It was also mentioned that the first cut should be made at the tree location exposed to the sunrise. Most interviewees considered that the best time of the year to make the cuts was before tree flowering, from August to October (Figure 5). Despite varying answers, however, 97% of interviewees performed bleeding during the nut collection period (between November and February).

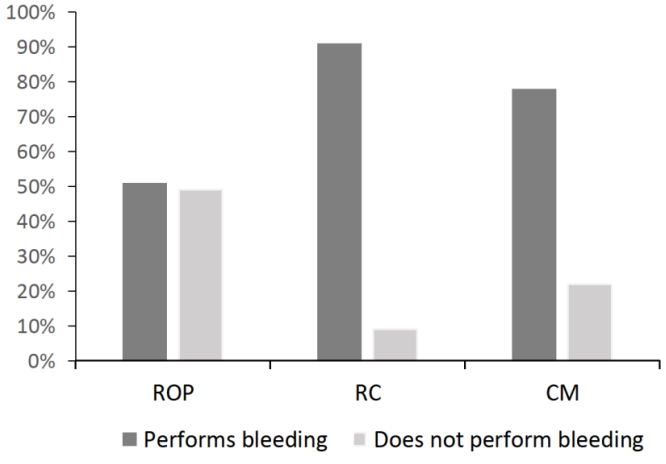

Figure 2 – Percentages of extractivists who do or do not practice bleeding in Brazil nut trees at the Rio Ouro Preto, Rio Cautário, and Chico Mendes extractive reserves.
ROP: Rio Ouro Preto; RC: Rio Cautário; CM: Chico Mendes.

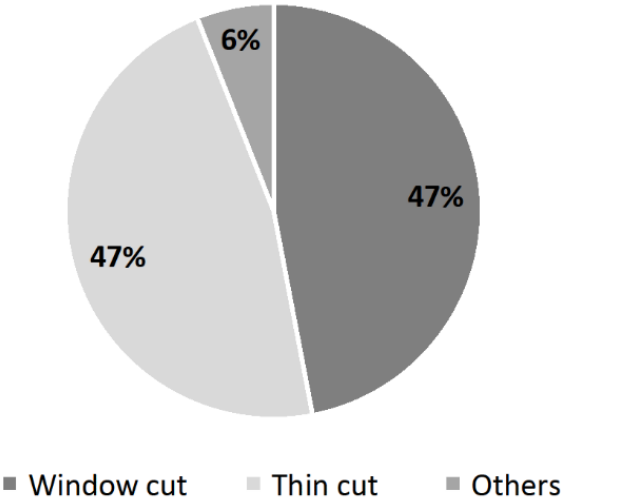

Figure 3 – Types of cuts performed by the interviewed extractivists (n=32) to bleed resin from Brazil nut trees.

Figure 4 –Types of cuts most mentioned by extractivists: window (A and B) and thin (C) cuts.
Source: Medeiros (2023).

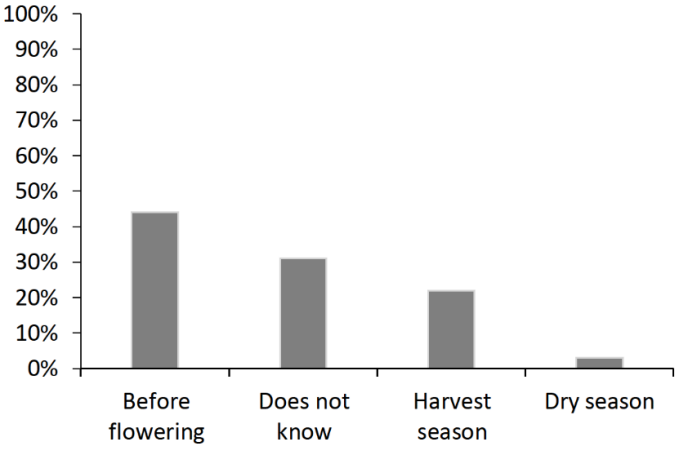

Figure 5 – The best time of year to perform bleeding on Brazil nut trees.

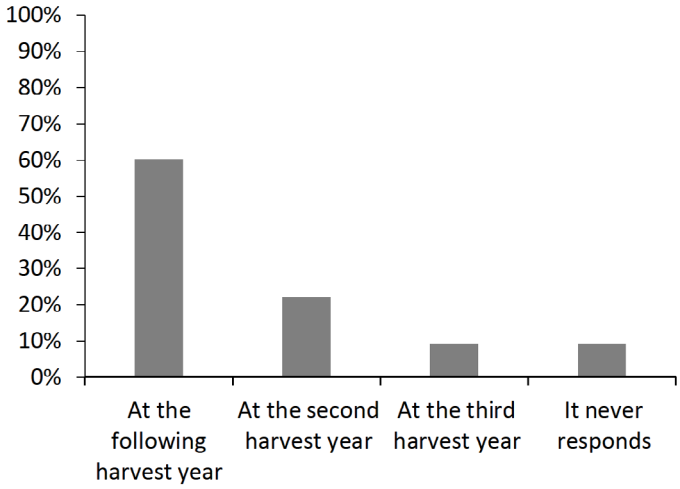

Figure 6 – Extractivists' perception of bleeding response time in fruit production.

Most extractivists (94%) renewed the cuts on Brazil nut trees. Some cut in the same tree location, while others cut elsewhere to avoid harming the trees. While 34% of the extractivists interviewed renewed the cuts every year, the others only repeated them when the cuts healed or when they noticed a decrease in fruit production. Overall, the period for cut renewal varied from 1–10 years.

Seventy-two percent of interviewees indicated some bleeding criteria: bleeding Brazil nut trees that did not produce well; cutting only those that were oozing resin and not producing or producing little; and not bleeding trees when pests were present.

The perception of 91% of the 32 extractivists regarding the effect of bleeding on Brazil nut trees was that the practice favors fruit production, whereas 9% had not yet observed positive results. They indicated that the fruit production response time could vary from one to three years (Figure 6) but the majority explained that a positive effect could be observed in just one year.

According to the Likert scale analysis and classification proposed by Brandalise et al. (2009), extractivists perceived a positive effect of bleeding on the production of Brazil nut tree fruit (3.1 points). This perception of positive effects was higher (3.7 points) when asked specifically about unproductive or low-production Brazil nut trees. Although the bleeding response time in fruit production was one year for most respondents, when it came to Brazil nut trees with low production, the response time was longer. Extractivists reported that they started to observe a positive response of low productivity trees in the first year, although good production only occurred 2–4 years later.

Regarding whether bleeding could kill Brazil nut trees, 97% of the extractivists reported that it could not. However, one of them believed that a large amount of resin (if not expelled) could kill the tree. Another extractivist reported that one tree he bled died due to an insect borer attack. He believed that this happened because he made the cut

during the new moon, favoring an attack that killed the tree from one year to the next.

Most interviewees (69%) were not aware of any use for the resin, whereas others mentioned its use in herbal medicine for cancer, diarrhea, diabetes, gastritis, liver and kidney inflammation, as a healing agent, and to control high blood pressure.

Discussion

Extractivists' perceptions of the bleeding practice

The bleeding practice was known among extractivists in the three reserves visited, and during the interviews, it was possible to perceive specificity in each protected area. In the RC Resex, the practice was still carried out as their ancestors had. These extractivists paid attention to details, considering the activity important for Brazil nut tree fruit production. In the CM Resex, the practice was generally performed because the extractivists heard that it was good for improving fruit production or because their father used to do it, but there was no detailed monitoring or clear perception about bleeding effects. In the ROP Resex, it was observed that those who practiced bleeding followed a similar logic as observed in RC Resex, namely that it was a highly regarded traditional practice among the older generation. However, it was in this reserve that a significant percentage of the interviewees either did not perform the procedure or had done it in the past but no longer did so.

Seeking to understand why some extractivists no longer carried out the practice in the ROP Resex, the older individuals pointed out that the youth were losing interest in traditional practices. This can be associated with the profile of the families in this reserve, as some were users who lived in the city and only went to the reserve during the nut collection period. Additionally, younger generations may have different interests than those who lived in and depend on the reserve for their livelihood.

Some studies indicated that older individuals excelled in traditional practices and possessed a more profound knowledge base (Caballero-Serrano et al., 2019; Galvão et al., 2024), whereas younger generations exhibited a lack of interest in learning and maintaining these traditional practices (Castro and Léda, 2023). While this has been a global observation (Robson et al., 2020), Silva et al. (2019) pointed specifically to a scenario of disillusionment among young people in CM Resex regarding life projects related to extractive reserve objectives. They expressed that extractive activities were not satisfactory for their well-being and they sought to migrate to the city. The authors documented a certain dissolution of the "extractivist" identity, a break in the succession of traditional occupations in these locations, and a downward trend in the traditional social reproduction of this population.

It is through traditional knowledge that extractivist populations integrate into their living environment, developing sustainable practices in the use of biodiversity products for social reproduction and income generation (Fernandes et al., 2022). These practices result from the coevolution between human populations and the various ways they have managed forests for generations. They are essential not only for biodiversity conservation, but also for biodiversity production, preservation of traditional knowledge, and consequently, improvement of other forest product management techniques (Tourinho et al., 2017; Lanza et al., 2022). Franco-Moraes et al. (2019) asserted that primary forests considered by scientists as "natural" and untouched by humans can become fundamentally social spaces, domesticated for human purposes, without excluding a multitude of other species and ecological processes. This relationship of care between traditional peoples and the forest makes the Amazon region a crucial space for biodiversity conservation, cultural conservation and renewal, and even global climate stability.

Extractivists' performance of the bleeding practice

The bleeding of Brazil nut trees is a technique practiced by extractivists to enhance the fruit production of trees that have never produced or have yielded few fruits. It is a traditional practice, with many having learned it from their parents, grandparents, and older rubber tappers. Additionally, some extractivists from the RC and ROP Resex, who previously worked in rubber estates, mentioned learning the bleeding technique from their employers. They recounted that at the end of the latex extraction period, typically towards the end of the dry season, their employers would hire rubber tappers to clean Brazil nut stands and subsequently collect the nuts. During this process, they would open collection trails, cut vines, and bleed Brazil nut trees. Bleeding was considered a crucial technique for maintaining Brazil nut fruit production. These employers owned extensive estates rich in rubber trees for latex extraction, many of which also had large *B. excelsa* populations. With the decline in rubber exports, they diversified activities by initiating Brazil nut collection, also known at the time as Pará nut (Alencar, 2019; Fonseca et al., 2019; Santos et al., 2021).

The management of Brazil nut stands in native forests is a human action that has been practiced over decades, employing a set of techniques and practices aimed at their use for various social and economic purposes, as well as maintaining nut production for future generations and preserving the species (Fonseca et al., 2019). The bleeding technique developed by extractivists involves cuts made in the tree trunks to expel the exudate (known as resin) present in the bark of the trees. According to extractivists' knowledge, this resin rises to the tree canopy, concentrating on the stalks (or peduncles) of the still young fruits and causing fruit abortion. In a study conducted in Acre, Pando, and Madre de Dios in the countries of Brazil, Bolivia, and Peru, respectively, Duchelle et al. (2014) documented extractivist reasoning that expelling the resin through cuts in the tree trunk reduces fruit abortion, resulting in increased production. The term "bleeding" is used by extractivists due to the resemblance of the exudate color to human blood and because, during the cut, the exudate flows through the tree's "vein", like blood.

Two types of cuts are performed: thin-cut, which is inclined to allow resin flow, like cuts made in rubber trees; and window-cut, which is a square incision where height and width are made in the same proportion. Before making the cuts, extractivists analyze the tree, and the cut is made in the area (referred to as veins or wrinkles) where resin is already emerging. One extractivist mentioned that in larger Brazil nut trees, it is more challenging to find the veins because they hide in the wood.

Regarding the depth of the cut, the majority of extractivists make a shallow incision only in the bark because this is where the resin is located. Furthermore, they are careful not to reach the deeper xylem or woody tissue of the tree. While wounding any tree can stimulate fruit production in the short term (Kramer and Kozlowski, 1979), injuring the xylem can lead to tree mortality. Some interviewees mentioned that they cut a few centimeters into the wood stating that the resin is more present in the wood, whereas, most extractivists showed special care in bleeding to avoid harming or killing the tree. They reported monitoring the tree's condition before bleeding so that they would avoid the procedure in case any problem is noticed. Still, one extractivist girdled the entire circumference of Brazil nut tree trunks. Studies indicated that continuous girdling can affect sap flow, impacting the nutritional quality of the fruits, and even leading to tree death (Schepper et al., 2010; Yang et al., 2019; Ran et al., 2022).

Another criterion used for making the cuts is the sun's position. The first cut is usually made on the side where the sun rises, and the second, in the direction where the sun sets, as informants believed that the resin is in these positions. Like the sun, the moon is a determining factor in choosing the day for the cut due to potential pest infestations. Extractivists believe that in the new moon phase, insects can cause damage to Brazil nut trees; therefore, they avoid bleeding during this phase. This concern about pest attacks when bleeding was also documented by Duchelle et al. (2014). It is common among traditional populations and farmers to carry out agricultural activities or manage forest products by observing lunar phases due to their belief in the importance of cosmic and gravitational forces on plants (Costa et al., 2018). Like extractivists consider lunar phases for bleeding, biodynamic farmers use lunar phases to guide their activities, including planting, cultural practices, and harvesting (Herrmann and Favaro, 2020; Leite and Polli, 2020).

Rivera (2005) explained the influence of lunar phases on plant development and growth in relation to resin movement in the tree. In the new moon phase, resin flow descends and concentrates in the root; in the waxing crescent phase, the resin begins to rise and concentrates in stems and branches; in the full moon, the resin rises and concentrates in the canopy branches, leaves, fruits, and flowers; and, in the waning phase, the resin flow begins to descend and concentrates in stems and branches. The author further stated that trees are more susceptible to insect or microorganism action between the waxing and full moon phases (in contrast to extractivists' concerns about greater insect presence during the new moon) due to the nutritional richness the resin offers and increased circulation dynamics. However, the intensity of potential insect damage depends on each tree's nutritional balance (Rivera, 2005).

Extractivists report that bleeding is primarily carried out on unproductive and low-yield Brazil nut trees. Some reported also performing it on productive trees when they are naturally expelling a significant amount of resin. For them, bleeding of Brazil nut trees is as crucial for fruit production as cutting vines. The bleeding technique is similar among the three reserves studied, only differing in the type of cut.

In terms of medicinal use, the therapeutic uses of the resin are similar to the literature on the medicinal use of the bark, which is generally employed for conditions such as diarrhea (Cymerys et al., 2005), anemia, hepatitis, or liver-related ailments (Silva et al., 2016). Laboratory analyses also suggest the presence of anti-inflammatory properties in the resin (Silva et al., 2023). Some extractivists believe that the resin can have the same medicinal effect as the bark, as it is present in the bark.

The management systems of traditional peoples or populations are often developed respecting nature cycles and their rituals. Ways of life are adapted to the availability of resources in the areas they inhabit, and the techniques used result from a network of diverse knowledge acquired through ancestral traditions, beliefs, and symbols (Diegues, 2000, 2019; Christopher et al., 2022).

Initiatives should be undertaken to address local demands and strengthen the development of traditional practices, encouraging the participation of younger generations in the daily routine and sustainable exploitation of natural resources. In this regard, incorporating biotechnology, bioeconomy, and natural resource management in these areas can contribute to community strengthening and continuity within Amazonian natural environments, thereby, promoting the conservation and protection of Amazonian forests.

Conclusions

Our results provide details from traditional extractivists of how the bleeding of Brazil nut trees is carried out. Bleeding is a traditional practice, passed down from generation to generation, recognized by the majority of extractivists interviewed. However, not everyone performs bleeding because they do not see positive results in fruit production or because they do not know how to apply the practice.

Bleeding is done by cutting the tree trunk to expel the resin. Two types of cuts were identified: one has a window-like format and the other is a thin fine cut. At Extractive Reserve Chico Mendes, only fine cutting is applied. The depth of the cut is generally the thickness of the bark. The intent of this traditional practice is to improve fruit production on Brazil nut trees that do not produce or produce few fruits.

The perception of most extractivists is that the bleeding of Brazil nut trees improves fruit production and when asked specifically if bleeding could result in tree mortality, 97% of informants stated that it could not. These perceptions have yet to be corroborated by other ways of knowing, such as investigative processes common to Western science.

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Author's contribution

Medeiros, T.K.A.: conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing – original draft; writing – review & editing. **Wadt**, L.H.O.: supervision, validation, visualization, writing – review & editing. **Kainer**, K.A.: supervision, validation, visualization, writing – review & editing.

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