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REVISTA BRASILEIRA DE GESTÃO E DESENVOLVIMENTO REGIONAL
V.22, N°4, Edição Especial 2026 | Taubaté/SP - Brasil | ISSN 1809-239x

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Received: 03/26/2026
Accepted: 09/29/2026

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ABSTRACT

Social movements constitute spaces for non-formal education, promoting learning based on experience, dialogue, and collective action. In this sense, we investigate how the social movements of babaçu coconut breakers constitute non-formal spaces for environmental and scientific education, by articulating scientific and traditional knowledge. Sixteen women from the Quilombola community of Olho d'Água dos Negros, located in Esperantina, Piauí, participated in the research. Data were collected through ethnographic records, participant observation, and semi-structured interviews. The results show that learning the art of breaking babaçu coconuts occurs predominantly within the family, especially with mothers, ensuring the intergenerational transmission of knowledge. We observed the integral use of the palm tree for food, income generation, medicinal purposes, and domestic practices, based on observation and experimentation. The coconut breakers recognize that this traditional knowledge contributes directly to the conservation of babaçu groves and respect for natural cycles. In this way, the practices of the coconut breakers constitute fundamental traditional knowledge for the maintenance of the ecosystem, highlighting elements of critical environmental education in their experiences and aspects of scientific education related to sustainability, especially in the conscious use of products and by-products of the babassu palm.

Keywords: Coconut breakers. Social Movements. Environmental education. Science education.

RESUMO

Os movimentos sociais constituem espaços de educação não formal, que promovem aprendizagens baseadas na experiência, no diálogo e na ação coletiva. Nesse sentido, investigamos como os movimentos sociais de quebradeiras de coco babaçu se constituem em espaços não formais de educação ambiental e de educação científica, ao articular saberes científicos e tradicionais. Participaram da pesquisa 16 mulheres da comunidade quilombola Olho d'Água dos Negros, localizada em Esperantina, Piauí. Os dados foram coletados por meio de registros etnográficos, observação participante e aplicação de entrevistas semiestruturadas. Os resultados evidenciaram que a aprendizagem da quebra do coco babaçu ocorre predominantemente no âmbito familiar, sobretudo com as mães, assegurando a transmissão intergeracional dos saberes. Observamos o uso integral da palmeira para alimentação, geração de renda, fins medicinais e práticas domésticas, fundamentado na observação e na experimentação. As quebradeiras reconhecem que esses saberes tradicionais contribuem diretamente para a conservação dos babaçuais e o respeito aos ciclos naturais. Dessa forma, as práticas das quebradeiras de coco configuram saberes tradicionais fundamentais para a manutenção do ecossistema, evidenciando elementos da educação ambiental crítica em suas vivências e aspectos da educação científica relacionados à sustentabilidade, especialmente no uso consciente dos produtos e subprodutos da palmeira babaçu.

Palavras-chave: Quebradeiras de coco. Movimentos Sociais. Educação ambiental. Educação científica.

INTRODUCTION

The babassu palm (*Attalea speciosa* Mart. ex Spreng.) is among the most emblematic species of the landscapes of north-central Brazil, particularly in Maranhão, Piauí, and Tocantins (Sodré et al., 2020). Local and traditional communities make extensive use of the palm because of its economic, social, and environmental value. Nearly all its components (trunk, leaves, fruits, and kernels) are used to produce food, handicrafts, cosmetics, and biofuels (Castro et al., 2020; Cordeiro; Moura, 2022).

Among the social groups maintaining longstanding, symbiotic relationships with babassu are the babassu coconut breakers, women whose livelihoods and household income depend directly on harvesting and processing the kernels (Santos; Lemos, 2021). Their activities extend beyond economic concerns to political resistance, collective organization, and the transmission of traditional knowledge. According to Siqueira et al. (2025), this relationship sustains a way of life characterized by reciprocity with the natural environment and appreciation of forest resources, which support their culture, work, and income.

The babassu coconut breakers' struggle for land, autonomy, and recognition led to organized social movements, including the *Interstate Movement of Babassu Coconut Breakers* (MIQCB). These organizations have become settings for political and cultural mobilization in which educational practices, knowledge exchange, and collective knowledge production emerge (Pinto; Machado; Kreutz, 2018). Although they operate outside formal schools, such settings can be understood as

spaces of non-formal education.

Despite increasing recognition of the coconut breakers' sociocultural and environmental importance, few studies integrate the educational, scientific, and environmental dimensions of their movements (e.g., Carvalho; Macedo, 2019; Brito; Barros; Lima, 2024). Most research focuses on economic, political, or gender-related issues, paying less attention to the educational potential of these spaces of resistance. Consequently, little is known about how the women's traditional knowledge and everyday management and conservation practices operate as processes of learning and the production of community-based scientific knowledge.

This study is grounded in the need to recognize and value the traditional knowledge and sustainability practices developed by babassu coconut breakers, who have historically maintained close relationships with their environment and contributed to the conservation of babassu palm forests. Passed down through generations, this knowledge has educational and scientific dimensions that express ways of learning, teaching, and caring for the environment outside formal schooling.

Examining the babassu coconut breakers' social movement through the lenses of environmental and science education can advance discussion of non-formal education, gender equity, environmental justice, and the preservation of traditional knowledge while increasing the visibility of these women as key actors in sustainability in northeastern Brazil. This study therefore addresses a gap at the intersection of the socioeducational and environmental dimensions of these movements. We asked: How does the social movement of babassu coconut breakers in the Olho D'Água dos Negros community of Esperantina, Piauí, function as a non-formal setting for environmental and science education while valuing traditional knowledge and environmental conservation?

Here, we investigated how babassu coconut breakers' social movements become non-formal settings for environmental and science education by connecting traditional knowledge, extractive practices, and conservation strategies. We emphasized the role of these women in developing sustainable practices and strengthening ecological awareness in rural communities. By examining these movements as learning environments, we seek to clarify how traditional knowledge and collective experience contribute to the appreciation of sociobiodiversity and to education committed to sustainability and socioenvironmental justice.

THEORETICAL FRAMEWORK

Environmental education establishes principles and practices essential to equitable social transformation and ecological conservation, processes that often depend on local collective commitment and interdependence (LLopiz-Guerra et al., 2024; Sato, 2002). From this perspective, education supports continuous, interdisciplinary learning that incorporates environmental and social dimensions. Educational goals and methods can be implemented in schools or non-formal settings to raise awareness of environmental problems affecting communities and the wider world (Huoponen, 2024).

According to Layrargues and Lima (2014), environmental education encompasses three broad political-pedagogical approaches - conservationist, pragmatic, and critical—which reflect different understandings of society - environment relationships. The critical perspective examines socioenvironmental inequalities and promotes emancipation from relationships of domination and injustice (Loureiro; Layrargues, 2013). It therefore extends the discussion beyond environmental conservation to include the social, political, economic, and cultural dimensions of the environmental crisis (Layrargues; Lima, 2014).

This perspective is consistent with science education aimed at developing critically engaged citizens and connecting scientific knowledge to everyday realities, since knowledge is not produced in isolation (Santana; Araújo, 2021). By the mid-1960s, educators had become increasingly concerned about environmental problems, and science education emerged as a means of connecting social issues with developments in science and technology (Santos, 2007).

The conception of science education proposed by Santos (2007) aligns with critical environmental education by emphasizing the social relevance of science: understanding scientific concepts also requires understanding their relationship with society. Among the various approaches to science education, the Science, Technology, Society, and Environment (STSE) perspective promotes critical citizenship and an interdisciplinary understanding of socioenvironmental problems by connecting scientific, technological, social, and environmental knowledge. These principles can be implemented in both formal and non-formal educational settings, expanding opportunities to connect science, society, and the environment.

Non-formal education involves intentional knowledge sharing in collective settings and differs from formal education through greater flexibility in timing, methods, and learning contexts (Gohn, 2006). It occurs in community associations, social movements, museums, protected areas, and other social environments, emphasizing lived experience, local knowledge, and participants' active involvement in knowledge construction (Arruda et al., 2021). Learning is therefore situated and encourages dialogue between scientific and traditional knowledge, an essential feature of critical environmental education that recognizes individuals and communities as agents in understanding and transforming socioenvironmental realities (Loureiro, 2004).

Non-formal learning settings are located outside schools but have educational purposes and are closely connected to social, cultural, and environmental contexts (Marandino; Selles; Ferreira, 2009; Zanini et al., 2021). Learning in these settings arises through interactions among people, their territories, and everyday practices, encouraging connections among different knowledge systems. Such spaces are therefore important for environmental education because they support situated reflection on socioenvironmental challenges and active community participation in developing sustainable solutions.

For Gohn (2011), social movements are important settings for non-formal education because they foster learning through experience, dialogue, and collective action. Among babassu coconut breakers, this learning is expressed through sustainable management practices, intergenerational knowledge transmission, the defense of socioenvironmental rights, and collective organization to conserve palm groves (Dias; Pereira, 2022). Beyond preserving traditional knowledge, the movement strengthens ecological awareness, values local knowledge, and encourages resistance to dominant models of natural resource exploitation (Pinto; Machado; Kreutz, 2018; Loureiro, 2004; Layrargues, 2012).

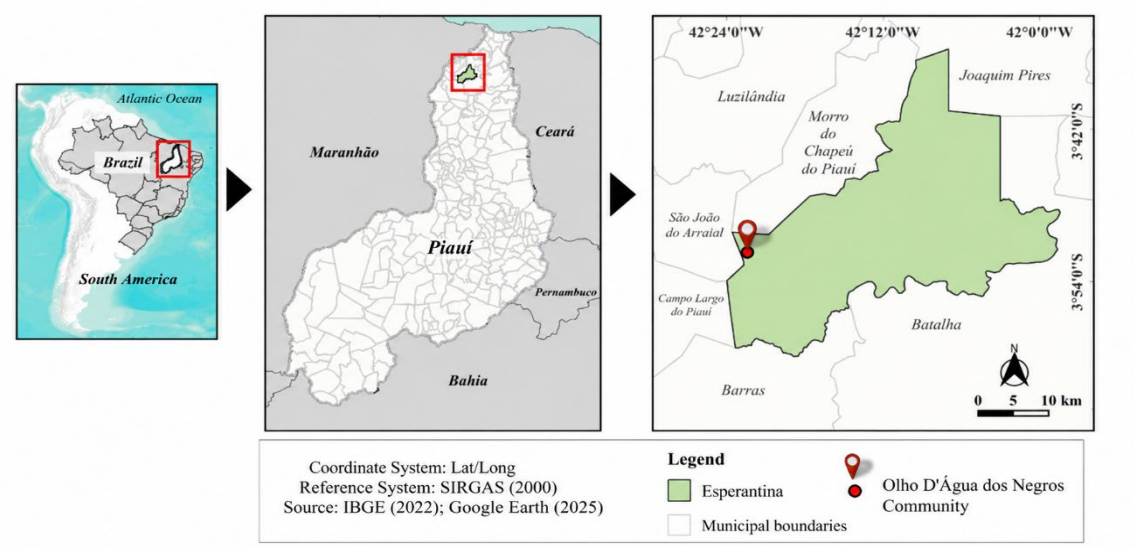
Babassu coconut breakers thus illustrate how environmental education can take shape in non-formal settings through connections among traditional knowledge, sustainable practices, and collective actions to conserve the environment and defend territories. The interaction of community knowledge, shared experience, and critical reflection supports educational processes beyond formal schooling, strengthens socioenvironmental awareness and cultural identity, and reinforces communities' agency in developing alternatives for sustainable resource use.

MATERIAL AND METHODS

STUDY AREA

The study was conducted in the *quilombola* community of Olho D'Água dos Negros (Figure 1), in municipality of Esperantina, north-central microregion of Piauí State, Brazil. Esperantina has approximately 40,970 inhabitants across 908.748 km², corresponding to a population density of approximately 45.08 inhabitants/km² (IBGE, 2022). Its vegetation lies in a transition zone combining physiognomic characteristics of the Cerrado and Caatinga ecorregions and includes endemic species harvested by local communities (Fé; Gomes, 2015; Fé; Gomes; Nascimento, 2021). These include babassu palm forests, or babassu groves, which form part of the secondary vegetation and have substantial socioeconomic and cultural importance for local residents (IBGE, 2012; IBGE, 2023).

Figure 1 | Location of the Olho D'Água dos Negros community in Esperantina, Piauí, Brazil



Source: prepared by L. S. Santos (2025).

Olho D'Água dos Negros illustrates the close relationship between vegetation and community livelihoods. Certified by the Palmares Cultural Foundation in 2005, the community depends on family farming and plant extraction, particularly babassu, its principal natural resource and a key element of collective identity (Fé; Gomes, 2015). Its current name reflects its history: formerly known as Olho D'Água dos Pires, the locality included a farm where workers dependent on extractive activities experienced exploitation and restricted access to natural resources. In 1990, prohibitions on using

these areas intensified conflicts and mobilized residents to organize meetings and collective resistance (Fé; Gomes, 2015).

The Community Development Association of Small Producers of Olho D'Água dos Negros (ADECOPOL) was founded in 1998, expressing the group's resilience and identity. In 2004, the Esperantina municipal government donated the community's lands to the association (Fé; Gomes, 2015). This was necessary because the community had previously depended almost entirely on babassu extraction for subsistence while being subject to landowners' demands, including exchanging coconuts for merchandise under threat of losing their homes.

Over time, the babassu coconut breakers organized and sought institutional support. They now receive support from MIQCB, particularly in securing access to land and strengthening coconut-related activities. The community also benefits from initiatives such as *Somos Nós Quebradeiras*, *Projeto Jandaíra*, the National Institute of Historic and Artistic Heritage (IPHAN), and the workers' union (on-site observation).

In addition to extractive activities, households engage in backyard production and sell fruits, vegetables, roots, poultry, pork, and products made from buriti palm (on-site observation). Olho D'Água dos Negros was selected because it represents the livelihoods and resistance of coconut breakers in Piauí and offers a relevant setting for observing non-formal educational practices in environmental and science education.

DATA COLLECTION AND ANALYSIS

This study adopted a mixed qualitative - quantitative approach in which quantitative data and qualitative interpretation complemented each other (Minayo; Sanches, 1993). It also employed an ethnographic approach (Ataídes; Oliveira; Silva, 2021), involving interactions with community members in everyday settings to understand their practices, knowledge, cultures, and social contexts.

Data were collected through semi-structured interviews conducted in April 2025 with 16 women coconut breakers from the *quilombola* community of Olho D'Água dos Negros. Participants were selected based on their active involvement in the community association and local social movements. Although the community has approximately 400 residents, including 120 association

members and 50 coconut breakers (on-site observation), only 16 actively participated in community projects and thus constituted the study population.

For each participant, we recorded (i) socioeconomic characteristics (age, education, marital status, household size, birthplace, and length of residence in the community) and (ii) traditional knowledge of babassu, including the importance of the palm, how coconut-breaking skills are acquired, knowledge transmission, uses of palm products, understanding of its reproductive cycle, and conservation-related practices.

Socioeconomic data were analyzed using descriptive statistics and reported as absolute and relative frequencies. Qualitative data were subjected to the content analysis proposed by Bardin (2016), including preliminary analysis, examination of the material, and interpretation of findings. Interview statements were grouped into thematic categories aligned with the study objectives and interpreted using frameworks of environmental education (Sato, 2002; Sauvé, 2005), critical environmental education (Loureiro, 2004; Loureiro; Layrargues, 2013), science education (Alves; Silva Neta; Montino, 2023; Gohn, 2011), and traditional knowledge research (Montenegro; Rodrigues, 2020; Nogueira, 2021). Findings were presented in tables, charts, and figures.

The study complied with ethical research procedures and was approved by the Human Research Ethics Committee of the Federal University of Piauí (CEP/UFPI), under CAAE no. 82735824.9.0000.5214 and approval no. 7.219.033. Participants provided free and informed consent (TCLE). The research was also registered with the National System for Management of Genetic Heritage and Associated Traditional Knowledge (SisGen).

RESULTS AND DISCUSSION

SOCIOECONOMIC PROFILE OF PARTICIPANTS

Sixteen women babassu coconut breakers aged 28–84 years participated, representing different generations involved in maintaining and transmitting the community's traditional knowledge. Educational attainment ranged from no formal schooling to completion of high school. Other socioeconomic characteristics are presented in Table 1.

Table 1 | Socioeconomic profile of babassu coconut breakers participating in the study, Olho D'Água dos Negros community, Esperantina, Piauí

Socioeconomic profile	N	%
Age group (years)		
21 to 30	2	12.50
31 to 40	4	25.00
41 to 50	2	12.50
51 to 60	3	18.75
61 to 70	1	6.25
71 to 80	3	18.75
81 to 90	1	6.25
Gender		
Female	16	100
Male	0	0.00
Other	0	0.00
Educational attainment		
No formal schooling	3	18.75
Incomplete elementary school (grades 1–5)	4	25.00
Completed elementary school (grades 1–5)	1	6.25
Incomplete middle school (grades 6–9)	2	12.50
Completed middle school (grades 6–9)	1	6.25
Incomplete high school	2	12.50
Completed high school	3	18.75
Marital status		
Single	6	37.50
Married	6	37.50
Domestic partnership	1	6.25
Widowed	3	18.75
Household size		
1	6	37.50
2	2	12.50
3	2	12.50
4	2	12.50
5	4	25.00
City of birth		
Esperantina	13	81.25
Matias Olímpio	1	6.25
Morro do Chapéu	1	6.25
Teresina	1	6.25
Length of residence in community		
Since birth	13	81.25
Since childhood	1	6.25
Since adulthood	2	12.5

Source: The authors (2026).

The data suggest a decline in young people's participation in traditional community activities, such as babassu coconut breaking, potentially associated with increased access to schooling. This finding is consistent with studies in similar settings, where school attendance has contributed to young people gradually disengaging from traditional productive practices that previously supported household subsistence (Silva; Aragão, 2023). Access to and continued participation in schooling may also reflect changes in coconut breakers' family dynamics associated with public policies and affirmative action initiatives, as observed by Ahlert (2013).

Regarding marital status, equal proportions reported being single and married (n = 6; 37.50% each), indicating diverse family arrangements. Six women (37.5%) lived in one-person households, whereas four (25.0%) lived in households of five people, reflecting variation in household composition. These findings suggest that coconut breakers play central roles in family organization and income generation. Coconut breaking thus extends beyond the domestic sphere traditionally assigned to women and constitutes a practice of autonomy, resistance, and the assertion of rights (Almeida; Santos, 2022).

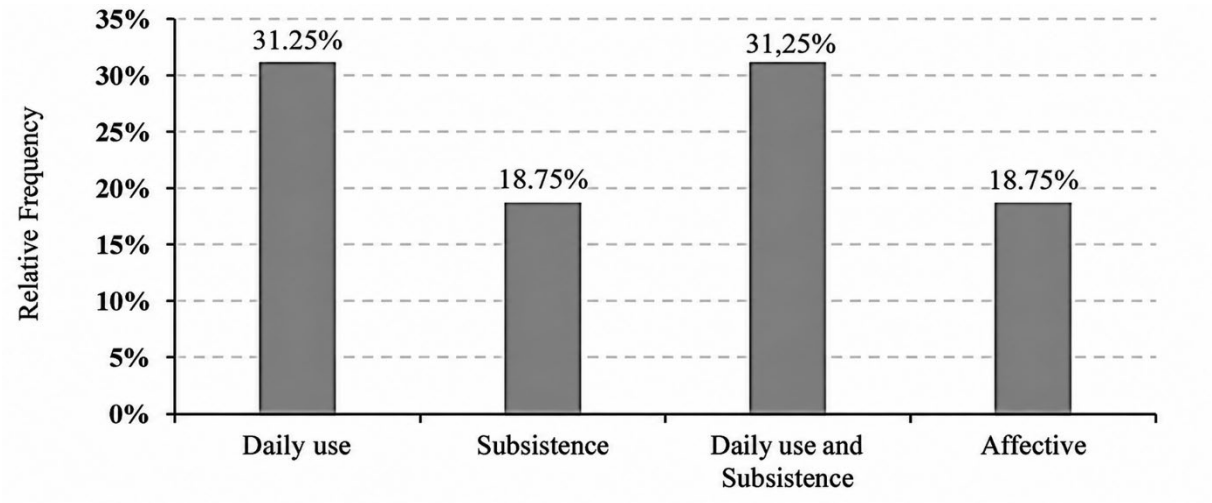
Thirteen participants (81.25%) were born in Esperantina, and the same proportion had lived in the community since birth; only two (12.5%) moved there as adults. This pattern suggests longstanding territorial ties and indicates that continued interactions with the environment help shape collective identity and a sense of belonging. Santos et al. (2013) argue that length of residence fosters place attachment and the consolidation and exchange of cultural knowledge among residents. Continued residence in the community may therefore have supported the maintenance and intergenerational transmission of babassu management knowledge and strengthened practices and values associated with natural resource conservation.

Babassu coconut extraction was identified as an important activity for women extractivists and a major source of household income and subsistence. This work is traditionally performed by women, with skills passed down from childhood (Silva; Machado, 2022). According to Santos et al. (2024), the knowledge acquired through coconut breakers' everyday experiences contributes to collective empowerment in their struggles. Its intergenerational transmission also positions these women as custodians of local knowledge, culture, and biological diversity.

TRADITIONAL KNOWLEDGE AND EDUCATIONAL PRACTICES WITHIN THE COCONUT BREAKERS' MOVEMENT

Participants most frequently emphasized the importance of babassu coconuts for everyday use (n = 5; 31.25%) and for a combination of daily use and subsistence (n = 5; 31.25%) (Figure 2), underscoring their central place in daily life and local livelihoods. These findings indicate that babassu-related knowledge is produced and shared through everyday interactions, constituting educational practices in which teaching and learning are inseparable, as emphasized by Freire (2002).

Figure 2 | Importance of babassu coconuts to women coconut breakers participating in the study, Olho D'Água dos Negros community, Esperantina, Piauí



Source: The authors (2026).

The daily uses described by participants involve extracting products and byproducts for household consumption, particularly food and family subsistence. Participant P.11 explained: *"Babassu gave us the means to carry on; it raised my family and my siblings, and today it is what keeps us going. The oil is our food, the charcoal is for cooking. We live from babassu today; my parents raised us on babassu. It is our food."*

Babassu products support both household consumption and income generation, reducing expenditure on purchased goods through the use of products such as charcoal and oil, which are also part of regional foodways and culture. Subsistence is particularly associated with income from selling babassu products and byproducts, a recurring theme in participants' accounts. As P.5 stated: *"Coconuts are very*

important to me. They are how I make my living." Working with babassu therefore enables women to support their families, obtain other foods, participate in commercial networks and institutional partnerships, and reinforce the value of their knowledge and territorial connections (Montenegro; Rodrigues, 2020).

Three participants expressed emotional attachment to babassu. One emphasized knowledge passed on by her mother, who taught her coconut breaking, while two women over 60 expressed affection and a sense of connection. These accounts suggest that babassu transcends its subsistence role and carries memories, knowledge, and emotions associated with different moments in women's lives, including hardship (Almeida; Santos, 2022). The palm thus mediates relationships with nature and the reaffirmation of women's culture, acquiring symbolic and emotional significance (Barbosa, 2011).

Consistent with this emotional significance, participants reported learning coconut breaking primarily within their families, particularly from mothers (n = 14; 56%) and fathers (n = 7; 28%), as well as grandparents and other community women (Figure 3). These findings show that skills are acquired through close personal relationships and shared experience, reinforcing intergenerational knowledge transmission and cultural and symbolic bonds.

Figure 3 | Sources of learning about babassu coconut breaking reported by participants, Olho D'Água dos Negros community, Esperantina, Piauí



Source: The authors (2026).

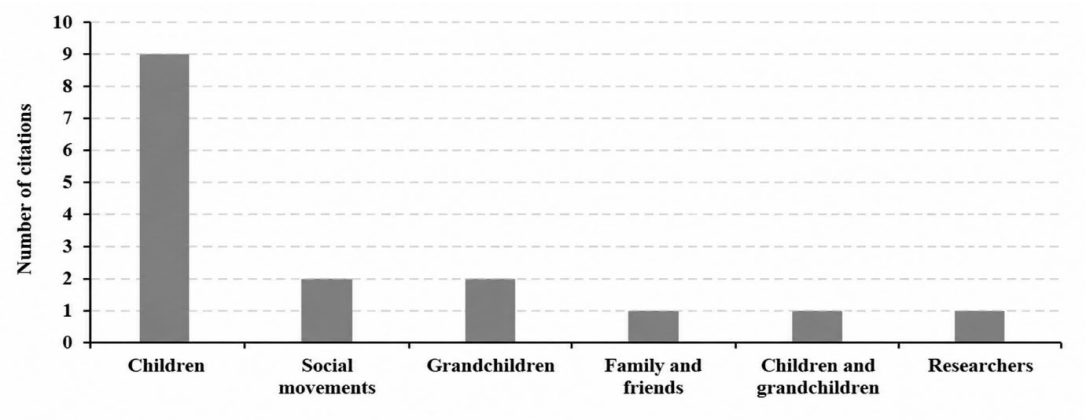
Traditional knowledge is passed down from parents to children through dialogue, group conversations, work, and songs. Learning is therefore embedded in social life and occurs both inside and outside classrooms. Work with the babassu palm provides a clear example of education grounded in traditional knowledge and community identity (Alves; Silva Neta; Montino, 2023). The coconut breakers' historical knowledge expresses their struggles and culture through group interactions and collective meetings (Silva; Almeida; Torres, 2023).

Repetition was the most frequently reported way of learning babassu-related work (n = 8; 50%), particularly by following parents who separated coconut halves so the girls could practice breaking them. Direct instruction was next most frequently mentioned (n = 5; 31.25%), provided by relatives and other coconut breakers through conversation and guidance. Observation was also identified as a learning strategy (n = 2; 12.5%) that stimulated interest in the occupation. These findings indicate that learning occurs mainly through everyday interaction, practical experience, and oral transmission, representing a non-formal, intergenerational educational process.

According to Mapurunga and Carvalho (2018), coconut breaking can also be understood as a lifelong learning process. Repeated activities from childhood, together with emotional ties to nature and babassu, contribute to implicit memories that guide practical skills. Learning occurs through observation, participation in extractive activities, and interaction with other community women. This educational process strengthens community ties and reaffirms the coconut breakers' collective identity while supporting the continuity of traditional practices for sustainable natural resource use.

All 16 participants reported sharing their babassu-related knowledge with others. Most transmitted this knowledge primarily to their children (n = 9; 56.25%) and, less frequently, to grandchildren (n = 2; 12.5%) (Figure 4), highlighting its intergenerational nature. Transmission takes place mainly during everyday extractive activities, when younger people observe and participate in coconut breaking. Beyond the family, social movements also provide opportunities to share knowledge (n = 2; 12.5%). Participants additionally exchange knowledge with other relatives, friends, and researchers, broadening the circulation of experience and recognition of babassu-related expertise.

Figure 4 | Recipients of participants' babassu-related knowledge in the Olho D'Água dos Negros community, Esperantina, Piauí



Source: The authors (2026).

These findings show that babassu coconut breakers' knowledge is passed between generations through continuous learning within communities. The transmission of traditional and practical knowledge contributes to environmental and science education, especially when enhanced through participation in social movements that encourage exchanges of experience and collective reflection (Melo; Albuquerque, 2025). Since education occurs in diverse settings, traditional knowledge also offers opportunities for formal teaching. Incorporating this knowledge into teaching practices and school curricula could support situated science education, connect academic knowledge with local sociocultural realities, and promote recognition of sociobiodiversity.

Participants' responses suggest that, in this context, scientific knowledge draws on traditional knowledge developed through observation, experimentation, and community experience. In line with Nogueira (2021), we understand that knowledge shared and reinterpreted over time provides an important foundation for environmental conservation and recognition of coconut breakers' ways of life.

ENVIRONMENTAL EDUCATION, SCIENCE EDUCATION, AND SUSTAINABILITY IN COMMUNITY PRACTICES

Regarding the everyday use of babassu palm products (Chart 1), oil (n = 15; 93.75%) and the sale of products (n = 13; 81.25%) were most frequently mentioned and represented important income sources. All participants (n = 16) reported producing charcoal from coconut shells. The epicarp is used mainly to start fires (n = 12; 75%) and less frequently in handicrafts (n = 1; 6.25%). Participants also reported extracting mesocarp flour (n = 9; 56.25%) for consumption, sale, and medicinal purposes. The endocarp had fewer reported uses, limited to handicrafts (n = 2; 12.5%) and charcoal production (n = 2; 12.5%), making it the least utilized part of the fruit.

Chart 1 | Everyday uses of babassu palm products by women coconut breakers participating in the study, Olho D'Água dos Negros community, Esperantina, Piauí

Product (palm component)	Use (type of application)	Frequency (Number of mentions)
Kernel	Oil production	15
	Sale	13
	Coconut milk production	3
	Handicraft production	2
	Beiju flatbread production	2
	Animal feed	1
Shells	Charcoal production	16
	Sale	1
Epicarp	Fuel (fire lighting)	12
	Not used	3
	Handicraft production	1
	Not reported	1
Mesocarp	Flour production	9
	Porridge preparation	5
	Sale	4
	Not used	4
	Cake production	3
Endocarp	Not reported	7
	Not used	6
	Handicraft production	2
	Charcoal production	2

Leaves	Roofing	15
	Mat weaving	7
	Basket making (cofos)	6
	Hand fan making	5
	Wall construction	3
	Handicraft production	2
	Use in homemade incubators	2
Trunk	Fertilizer production	7
	Not used	7
	Palm heart extraction	2
Palm weevil larvae (gongo)	Food (fried)	13
	Oil production	3
	Not used	3
Other	Not reported	15
	Palm spathe (games/handicrafts)	1

Source: The authors (2026).

Babassu palm leaves have several uses, especially roofing (n = 15; 93.75%). Historically, they also symbolized resistance when used in place of clay to construct house walls because landowners restricted access to land and building materials. Fallen palm trunks are used as fertilizer (n = 7; 43.75%), while palm hearts are eaten (n = 2; 12.5%). Participants also reported using palm weevil larvae (popularly known as *gongo*) as food (n = 13; 81,25%) and to produce hair oil (n = 3; 18,75%). Finally, one participant described using the palm spathe (*capemba*) in childhood games and handicrafts (n = 1; 6,25%).

As shown in Chart 1, the babassu palm supports diverse uses, including food, income generation, housing construction, and household products, making it central to family subsistence. Using kernels, shells, mesocarp, leaves, trunks, and palm weevil larvae demonstrate an integrated resource-use system in which nearly every part of the palm and fruit contributes to daily activities. Such comprehensive use reduces waste, strengthens economic autonomy, and supports sustainable practices, illustrating the close connection between traditional knowledge and natural resource conservation. This knowledge can inform university outreach, environmental education programs, and public policies aimed at sustainable sociobiodiversity use and the strengthening of traditional communities.

The women's accounts also reveal elements of critical environmental education by connecting historical memory, social injustice, and growing awareness of rights and autonomy. Participant P.7 recalled

past experiences of exploitation and denial of rights, especially access to land and housing: *"We roofed houses and made the walls, because nobody built them with clay; the bosses would not let us. Now they are made of bricks. Today people have freedom. In my parents' time, poor people did not even have the right to open a bank account; they knew nothing beyond the bush. We had no opportunities. Those bosses are gone; we do not have bosses anymore. Poor people have learned about their rights, and today we have the right to our homes. You build your house how you want, however you can."*

In this context, the babassu coconut breakers' struggle plays a central role in conserving babassu groves against the impacts of agribusiness, as their longstanding and deeply felt relationship with the environment motivates them to address socioenvironmental problems arising from competing interests, as discussed by Sauvé (2005). Participants' accounts also reveal practices associated with community-based science education, such as the medicinal use of mesocarp flour, based on knowledge developed through observation, experimentation, and collective experience. These practices constitute traditional knowledge in dialogue with scientific knowledge and reaffirm the central role of community experience in educational processes (Nogueira, 2021).

Regarding babassu fruit production, 11 participants (68,75%) reported that coconuts are available throughout the year, whereas five (31,25%) indicated that production is limited to seasons. Although the palm bears fruit year-round, availability increases during the main harvest season (Gusmão; Porro, 2022), potentially explaining differences in participants' perceptions. These findings demonstrate how coconut breakers develop knowledge through sustained interactions with their surroundings, informing decisions, resource use, and care for palm groves. Their mastery of different coconut-processing stages, combined with collective action, positions these women as custodians of sociobiodiversity, as noted by Dias and Freire (2020).

When asked about measures to conserve babassu groves (Figure 5), the most frequently mentioned action was protecting native vegetation (n = 10; 62,50%), including preventing deforestation and fires in palm groves. Awareness raising and community mobilization were mentioned by two participants (12,50%), who described advising others and participating in collective meetings and activities defending babassu. One participant also mentioned sustainable management through the practice of not cutting fruit clusters from the palm.

Figure 5 | Babassu grove conservation and sustainable management practices reported by women coconut breakers participating in the study, Olho D'Água dos Negros community, Municipality of Esperantina, Piauí



Source: The authors (2026).

Participants' accounts illustrate these practices. P.14 stated, *"Do not destroy the palms or cut off the coconut bunches, because that delays production"*; P.12 explained, *"We talk to people and tell them not to burn or make fields too close, because if they do, the palms will certainly die".* These findings suggest that conservation actions are informed by practical knowledge and awareness of human impacts on babassu groves, reinforcing the women's role as local environmental stewards. Conservation is associated primarily with direct protection of vegetation and, to a lesser extent, management practices and community mobilization.

We observed a caring relationship between the babassu coconut breakers and the palms, grounded in respect for natural cycles. Social movements play an important role in developing women's ecological and political awareness as they confront challenges to establishing sustainable practices (Layrargues, 2020). Consistent with this understanding, most interviewees (n = 15; 93,75%) stated that the community's traditional knowledge of babassu directly contributes to environmental conservation.

Participants explained how community traditional knowledge contributes to environmental conservation in the following statements:

> *"Because when a palm is old and falls, it becomes wood, and that wood nourishes plants".* (P. 10)

> *"Because we are always talking with the people here, telling them they cannot do that, that they have to think about tomorrow so they will not end up without coconuts to break and make their oil".* (P. 14)

> "Because, in fact, these movements were created precisely to benefit it [the palm], and not only it but the community's environment as well. I think it is the whole environment—the water, the palms, everything. These movements, meetings, and gatherings all aim to leave things as they are, not disturb them, just preserve them, because they could disappear. They are already disappearing because of road construction. There are reservoirs, streams, and crossings that no longer work because of the roads; it is hard to understand. There are fires too, but the movements contribute a great deal". (P. 15)

The community work undertaken by women coconut breakers is essential for environmental conservation and the maintenance of babassu groves and other species, as participant P.15 emphasized. The social movements and collective actions involving these women thus have positive effects on the ecosystem. Despite numerous difficulties, their struggle and determination reflect a relationship of care and integrity toward the palm and the wider environment. This relationship involves understanding conservation needs, improving quality of life through traditional knowledge, and exercising rights and freedoms they have secured (Souza, 2025).

The knowledge and practices of coconut breakers therefore extend beyond production to encompass environmental conservation, cultural affirmation, and social transformation. In addition to supporting conservation, their knowledge offers valuable resources for formal education by helping contextualize science and environmental education. It can also inform public policies to protect babassu groves, recognize traditional knowledge, and strengthen extractive communities' rights.

The relationship with babassu, mediated by collective work and intergenerational knowledge transmission, reflects sustainable ways of life grounded in respect for natural cycles and the defense of territory. Babassu coconut breakers consequently play a central role as agents of care and socioenvironmental resistance, reaffirming that grove conservation is closely connected to recognition of their knowledge, community organization, and rights.

CONCLUSIONS

The practices of coconut breakers in the *quilombola* community of Olho D'Água dos Negros, Esperantina, Piauí, reveal traditional knowledge essential for conserving babassu groves and maintaining sociobiodiversity. These practices reflect environmental education processes embedded in everyday experience, shaped by care for nature, intergenerational knowledge transmission, and defense of territory. They also demonstrate elements of science education through observation, experimentation, and the organization of knowledge concerning the sustainable use and management of palm products and byproducts.

The babassu coconut breakers' social movements play a central role in community education by expanding awareness of rights, strengthening collective organization, and recognizing knowledge associated with extractive livelihoods. These settings facilitate the circulation, reinterpretation, and strengthening of local knowledge and expand its educational, political, and environmental significance. The knowledge produced by babassu coconut breakers thus constitutes an important cultural and socioenvironmental heritage that contributes to natural resource conservation and territorial identity.

These insights can inform public policies for babassu grove conservation and recognition of traditional communities, as well as teaching, research, and outreach initiatives that strengthen dialogue among universities, schools, and communities. However, a limitation of the study is its small number of participants relative to the total number of affiliated coconut breakers. Future research should include other extractive communities to broaden understanding of the contributions of traditional knowledge to environmental education, science education, and sociobiodiversity conservation.

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