

Strategies for managing agrobiodiversity by peasant farmers in the Cerrado-Caatinga ecotone, Southwest Piauí, Brazil

Estratégias de manejo da agrobiodiversidade por agricultores camponeses do ecótono Cerrado-Caatinga, sudoeste do Piauí

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ABSTRACT

The relevance of agroecological strategies for conserving agrobiodiversity in areas with rich biodiversity, such as the Cerrado-Caatinga ecotone, is not well studied. The objective of this study is to understand the uses and management of rural agroecosystems in Southwest Piauí, Brazil, focusing on the relationships between biological and cultural diversity within the context of expanding the agricultural frontiers in Matopiba. The fieldwork data were collected through semi-structured interviews with 18 informants, exploratory walks through the agroecosystems, participant observation, and photographic documentation. The key strategies for managing agrobiodiversity by peasants include safeguarding biological diversity (i.e. native seeds, and agricultural species and varieties), and the multifunctionality of managed spaces (i.e. plant harvesting and animal husbandry in the communal areas of Cerrado and Caatinga). As a result, we identified over 80 species cultivated in small-farms and home gardens within the scope of managed plants, along with high intraspecific diversity. These practices reflect a co-evolutionary relationship between peasant farmers and their environment, where diversity is essential

for the climate resilience of agroecosystems and the food security of communities. The expansion of soybean monoculture represents severe threats through deforestation, loss of communal territories, and the homogenisation of cultivated species, endangering both ecological and biocultural diversity.

Keywords: Peasant farmers. Agroecosystems. Agroecology. Agribusiness. Serra Vermelha. Piauí. Cerrado-Caatinga ecotone.

RESUMO

A relevância das estratégias agroecológicas para a conservação da agrobiodiversidade em áreas com rica biodiversidade, como o ecótono Cerrado-Caatinga, não é bem estudada. O objetivo deste estudo é compreender os usos e a gestão dos agroecossistemas rurais no sudoeste do Piauí, Brasil, com foco nas relações entre diversidade biológica e cultural no contexto da expansão das fronteiras agrícolas em Matopiba. Os dados de campo foram coletados por meio de entrevistas semiestruturadas com 18 informantes, caminhadas exploratórias pelos agroecossistemas, observação participante e documentação fotográfica. As principais estratégias para o manejo da agrobiodiversidade pelos camponeses incluem a salvaguarda da diversidade biológica (ou seja, sementes nativas, espécies e variedades agrícolas) e a multifuncionalidade dos espaços manejados (como a coleta de plantas e a criação de animais nas áreas comunais do Cerrado e da Caatinga). Como resultado, foram identificadas mais de 80 espécies cultivadas em pequenas propriedades e quintais no escopo das plantas manejadas, juntamente com alta diversidade intraespecífica. Essas práticas refletem uma relação coevolutiva entre os agricultores camponeses e seu ambiente, em que a diversidade é essencial para a resiliência climática dos agroecossistemas e a segurança alimentar das comunidades. A expansão da monocultura da soja representa ameaças graves por meio do desmatamento, perda de territórios comunais e homogeneização das espécies cultivadas, colocando em risco tanto a diversidade ecológica quanto a biocultural.

Palavras-chave: Agricultores camponeses. Agroecossistemas. Agroecologia. Agronegócio. Serra Vermelha. Piauí. Ecótono Cerrado-Caatinga.

1 INTRODUCTION

Agricultural biodiversity, or agrobiodiversity, is essentially a product of the interrelationship between humans and natural ecosystems, developed by farmers over the last 10,000 to 12,000 years (Santilli, 2014). According to the definition of the Convention on Biological Diversity (CBD), “agrobiodiversity is a broad term that includes all of the components of biodiversity that are relevant to agriculture and food, and all the components which compose agroecosystems: the variability of animals, plants, and microorganisms at the genetic level of species and ecosystem necessary to sustain the key functions of ecosystems, their structures, and processes” (CBD, 2000).

Agrobiodiversity plays a crucial role in nutritional diversification, sustainable production, and food sovereignty (Jones *et al.*, 2021). The Food and Agriculture Organization (FAO) Report (2019) highlights the importance and decline of global agrobiodiversity, as well as the need to transition towards more sustainable and resilient food systems. The excessive dependence on a few species, varieties, and breeds, as well as the disappearance of pollinators and other organisms which support food and agriculture, threatens the sustainability of our food system and impacts human and environmental health.

The primary cause of agricultural biodiversity loss has been the replacement of local and traditional varieties by “modern” high-yielding varieties with narrow genetic diversity (Empeaire, 2020). The shift towards industrial agriculture not only represents a threat to the diversity of cultivated plants, but also to the knowledge, rights, and livelihoods of indigenous and traditional people in the tropics (Santilli, 2009). Furthermore, monocultures and other simplified agricultural production systems are more prone to pest and disease outbreaks, reduced soil quality, and experience more frequent crop losses (Altieri; Nicholls, 2004).

Ove and Spaner (2007) summarise three main strategies for agrobiodiversity conservation: a) *in situ* conservation of genetic diversity through sustainable crop management and maintenance of locally adapted varieties; b) *ex-situ* conservation through storing seeds and genetic material in germplasm banks; and c) implementing agroecological techniques, such as agroforestry, intercropping, and crop rotation, which contribute to biodiversity conservation, improve soil health, and minimise the use of chemical inputs. Although *in situ* conservation has historically been neglected (Brush, 1995), this mechanism provides a valuable complement to *ex-situ* methods by preserving biological and social processes.

Brazil is a centre of agricultural diversity, where *in situ* conservation (by farmers) predominates, contrasting with the *ex-situ* conservation strategies (in germplasm banks) traditionally promoted by the Empresa Brasileira de Pesquisa Agropecuária (Embrapa) (Eloy et al., 2018). *In situ* conservation of agrobiodiversity reduces the vulnerability of traditional, biodiversity-rich agricultural systems, in contrast to introducing modern species and varieties (Wood; Lenné, 1997). Santilli (2014) points out the scarcity of agricultural policies dedicated to preserving agricultural biodiversity (one of the few public policies on the topic is the National Policy of Agroecology and Organic Production – Pnapo). In this context, experiences of systematisation and patrimonialisation of agrobiodiversity (Empereaire; Cunha; Tozi, 2017; Empereaire; Eloy; Seixas, 2016), along with seed networks (Bevilaqua et al., 2014; Coomes et al., 2015) provide important solutions to the threats of biodiversity loss, contributing to the conservation of agrobiodiversity, food security, and climate resilience.

The agricultural practices of indigenous and traditional people play a central role in safeguarding a rich diversity of native and cultivated plant species (Carvalho, 2013; Eloy et al., 2020). Santilli emphasises that “the cultural processes, knowledge, practices, and agricultural innovations developed and shared by farmers are a key component of agrobiodiversity” (Santilli, 2009, p. 94). Diniz et al. (2024) emphasise that the transition to more sustainable production models requires new perspectives on the human-nature relationship which value the plural understanding of knowledge present in sociobiodiversity. These new perspectives must take into account biocultural diversity, which consists of the interaction between natural systems and human cultures (Diniz et al., 2024).

This study area becomes highly relevant in the southwest of Piauí due to the consolidation and expansion of the agricultural frontier, most notably soybean cultivation, in the Piauí Cerrado, which constitutes one of the areas of the Matopiba territory (acronym for the states of Maranhão, Tocantins, Piauí, and Bahia), created by Decree 8.447/2015 (Brasil, 2015). Soybean cultivation has been responsible for increasing deforestation in the Cerrado, promoting an indiscriminate use of agrochemicals, and exacerbating the water and climate crises (Eloy et al., 2023; Salmona et al., 2023; Silva et al., 2021), as well as intensifying social and territorial conflicts in the region (Favareto, 2019).

Given this context, the present study focuses on the Cerrado-Caatinga ecotone regions in the southwest of Piauí, historically occupied by indigenous, traditional communities, and peasant farmers. Despite the importance of agrobiodiversity conservation, the agroecological strategies of family-based peasant agriculture and their interface with high biodiversity areas (such as the Cerrado-Caatinga ecotone) are still poorly studied (Souza et al., 2017). Based on an understanding of the relationship between biological and cultural diversity, this article aims to analyse the usage and management forms of peasant agroecosystems in the southwest of Piauí. Specifically, we aim to investigate the strategies employed by peasant farmers to promote agrobiodiversity in the soybean monoculture agricultural frontier and identify potential impacts of agribusiness in the studied area.

2 METHODOLOGY

2.1 STUDY AREA

The study area is located in the municipalities of Redenção do Gurgueia and Curimatá, in the southwest of Piauí (Figure 1). This region is part of the Chapadões da Serra Vermelha, an ecotone area between the Cerrado and Caatinga, characterised by high biological diversity (Castro *et al.*, 2008). Santos Filho and Souza (2018) estimated the existence of approximately 280 plant species and 79 animal species in the ecotone. This region is included in the priority areas for Conservation by the Brazilian Ministry of the Environment (MMA, 2018) due to the “irreplaceability” of its flora.

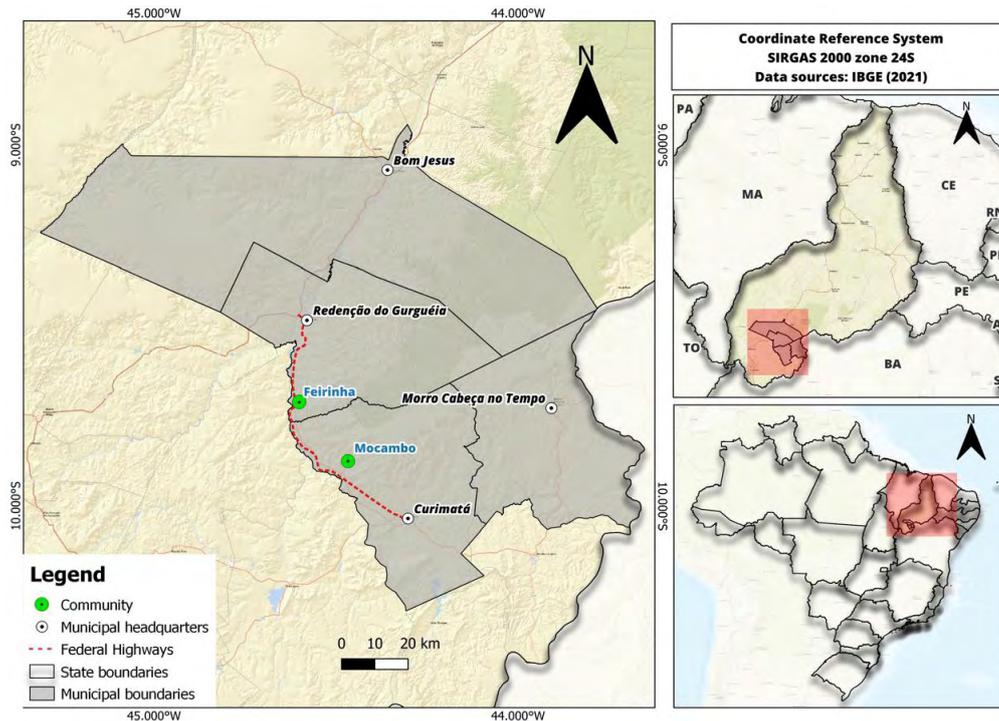


Figure 1 – Location of the studied communities along sections of PI-257.

Source: Prepared by Arthur Wendel (2023).

The Serra Vermelha region consists of “an important area of environmental interest in the northeastern hinterland, possessing one of the greatest biodiversity concentrations in Brazil, with its reddish rock outcrops and various other natural environments” (Batista; Albuquerque, 2019, p. 3). This region has been the target of many disputes due to pressure from expanding the agricultural frontier from Matopiba, and it has now been claimed by the environmental movements as a protected area contiguous to the Serra das Confusões National Park (Valor Econômico, 2023).

The local species are generally adapted to the conditions of water scarcity during the dry season and high temperatures. The “hypoxerophytic Caatinga” is characterised by heterogeneous vegetation, dominated by shrubs, herbaceous plants, and trees with adaptive and resilient capacities to fire and xerophytic conditions (Sousa *et al.*, 2024).

2.2 STUDIED COMMUNITIES

The subjects in this study are referred to as peasant farmers. From the perspective of the agrarian capitalism paradigm, the conceptual notions of family farming focus on the idea of the peasant as synonymous with primitive, a remnant of feudalism, whose tendency is to disappear with the expansion of capitalism. “Thus, the identity dimensions that nourish the categories ‘peasant’ and ‘family farmer’ are denied, removing any reference to the constitution of political subjects,” and their sectoral participation (Wanderley, 2014, p. 31). Therefore, despite profound internal changes, the peasant way of life is maintained through resistance and reinvention (Eloy *et al.*, 2020; Fabrini, 2011).

The study was conducted in two communities located along sections of the PI-257 highway, the main access road to the region (Figure 1). The Feirinha community is situated in the heart of the agricultural frontier, where land appropriation is advanced, driven by the Matopiba project (Favareto, 2019). Most agroecosystems in this area feature plateaus and caatingas, with private land to the east and the Paraim River to the west, which borders the tablelands and floodplains along its course. The Feirinha community is home to 39 families (146 people), the majority of whom are adults. The land is registered under the names of three local families, each owning around 78 hectares.

The Mocambo community is home to eight families, most of whom are adults over 30 years old. This community is located approximately 6 km from the PI-257 highway, and the residents live in Caatinga areas with tablelands, floodplains, and in rare cases plateaus. The families in Mocambo own between 100 and 156 hectares of land, where they grow their main crops on the floodplain lands. Unlike in the Feirinha community, where cattle roam freely on the plateaus from November to May, part of the cattle in Mocambo are kept year-round within the caatingas, close to their household.

Peasant families produce for subsistence and sell the surplus, while also saving seeds for the next planting season. There are variations in the crops depending on the space (farms and home gardens) and the species cultivated. Similar to other studies, peasant farmers in this area adopted traditional agricultural practices such as slash-and-burn systems, including periods of fallow, intercropping, and crop rotations (Eloy *et al.*, 2020; Emperaire, 2020). The productive activities are complemented by the collection of fruits, wood, medicinal plants, and honey, among others (Sousa; Silva, 2022).

2.3 METHODOLOGICAL PROCEDURES

A total of 18 semi-structured interviews were conducted, with 10 in the Feirinha community (representing 10% of the adult population) and 8 in the Mocambo community (n = 18 interviews). The interviews included 10 men and 8 women, aged between 23 and 85 years (average age of 61 years). The interviews took place between October 2022 and April 2023. All interviews were conducted by the first author of this paper, who himself is from a village in the region of the Feirinha community. The snowball sampling method was used in Feirinha to select the interviewees (key informants) (Baldim; Munhoz, 2011), while all families in Mocambo were interviewed.

Prior to conducting the interviews, each participant was presented with an informed consent form (ICF) which detailed the research procedures, content, and expectations. Formal consent was obtained by each interviewee signing the ICF.

The interviews addressed various topics, including the use of cultivated spaces (agroecosystems), cultivation of species (agrobiodiversity), and external influences (agribusiness), among others. Complementing the interviews, transect walks and direct observation of the agroecosystems were conducted to observe the managed spaces, such as farms, home gardens, and others. Data was recorded using a mobile phone recorder, photographic documentation, and field notes.

In addition, a survey was conducted on the plants cultivated and collected by the interviewed peasant farmers in each community based on the interviews and observations. This survey involved documenting the cultivated and managed plants through transect walks in the agroecosystems. The survey included the species' names, general observations, and photographic records with the owner(s) of the agroecosystem. Although no botanical specimens were collected, photographic records facilitated botanical identification of the species by specialists in the field.

3 RESULTS AND DISCUSSION

3.1 PHYTO-PHYSGNOMIC DIVERSITY OF PEASANT AGROECOSYSTEMS

Agroecology operates on the principle that peasant agroecosystems are modifications of natural ecosystems through human activity (Gliessman, 2002; Hart, 1985; Petersen *et al.*, 2017). These systems are considered open and structurally subordinate to larger-scale systems, engaging in exchanges of matter, energy, and information with external subsystems. Each subsystem's role is interaction and support, contributing to the self-organising dynamics of the entire system (Hart, 1985).

Understanding peasant agroecosystems is inseparable from understanding the way of life of the people involved (Silva, 2021). Family farmers and peasants create and recreate their own knowledge, lifestyles, and agricultural systems, rooted in ancestral knowledge, while constantly reformulating these practices as necessary within the constraints of space, time, and daily realities (Conte; Souza, 2013). In this sense, they are highly skilled at producing “abundant and diverse food in harmony with nature, respecting its cycles, recovering and maintaining what is essential [...]: water, fertile soils, biodiversity, cultural wealth, and the wisdom of peoples and communities” (Monteiro, 2012, p. 68), which sustain these spaces.

We observed that the peasants in the studied communities manage a diverse range of agroecosystems, which include different phyto-physiognomic types in both family and communal production areas (Figure 2).

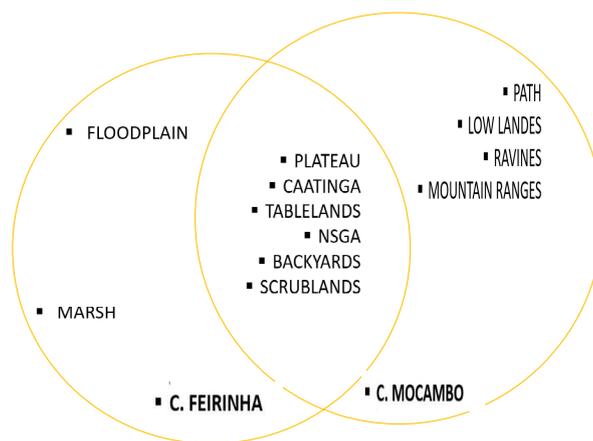


Figure 2 – Overview of the phyto-physiognomic diversity of agroecosystems in the studied communities; (NSGA = Social Management Core of Agroecosystems)

Source: Authors (2024).

The productive areas include wide phyto-physiognomic diversity, with family production spaces such as lowlands and wetlands. It was observed that the ecological diversity of these agroecosystems leads to common usage and management forms among peasants in both of the studied communities. These spaces host annual agricultural species, fruit trees, medicinal plants, and ornamental species (Table 1), along with animal husbandry (chickens, goats, etc.).

From the perspective of the farmers, certain areas are considered “weaker” lands, making them more suitable for crops such as cassava (*Manihot esculenta Crantz*). The plateaus and home gardens are also referred to as “higher lands,” where dryland crops (which rely solely on rainfall) such as beans (*Vigna unguiculata* (L.) Walp.), corn (*Zea mays* L.), and pastures like *Andropogon* grass (*Andropogon gayanus* Kunth) are introduced.

The lands along the riverbanks (floodplains) are rich in water and have moist soils, and so are ideal for crops adapted to water stress, such as rice grass (*Oryza sativa* L) (Figure 3). The lowlands (also known as wetlands) are low, sandy areas along streams, well-suited for various types of cultivation, including mangaba rice and cassava. Wetlands have similar characteristics to the lowlands but are closer to small ravines where water runs off. These areas are considered more productive in agroecosystems. Peasants traditionally take advantage of the end of the dry season (March to May) due to the land’s capacity to sustain crops and provide better yields, thus ensuring food security throughout the year.



Figure 3 – Examples of flooded systems such as floodplains and lowland areas.

Source: Authors (2024).

The communal areas include caatinga, plateaus, swamps, drylands, and ravines. From the farmers’ perspective, both areas have unique features, often containing endemic species useful for local collection and extraction.

Tree species dominate in the caatinga, creating a denser landscape compared to other areas, where farmers gather fruits such as caatinga passion fruit (*Passiflora cincinnata* Mast.), bat fruit (*Dipteryx lacunifera* Ducke), cambui (*Myrcianasp.*), etc., for consumption. The landscape in the plateaus is more open, with a variety of species, including twisted, low, and shrubby trees typical of the Cerrado. Here, peasants collect fruits such as black puçá (*Mouriri pusa* Gardner), pequi (*Caryocar coriaceum* Wittm.), mangaba (*Hancornia speciosa* Gomes), and olho-de-boi (*Diospyros lasiocalyx* (Mart.) B.Walln.), which are valuable for family consumption. Additionally, both areas present in both communities are used for extractivism and cattle grazing from November to April.

There are noticeable differences regarding other communal use areas between the communities, with peasants taking advantage of the endogenous potential of the agroecosystems as they are offered. For instance, the processing of buriti palm trees (*Mauritia flexuosa* L.f.) and their derivatives, including fruit

consumption during seasonal periods, pulp preservation for year-round use, and commercialisation, is a significant activity performed by peasants in Feirinha, thanks to the presence of swamps. The swamp areas are abundant in water, and so they are also used for growing crops such as rice grass, corn, and pumpkin (*Cucurbita moschata* Duchesne), among others.

Peasants in the Mocambo community have larger expanses of dryland areas, which are nearly barren and covered with low vegetation. Species such as caroá (*Neoglaziovia variegata* (Arruda) Mez) are extracted in these areas for making ropes, and xique-xique (*Pilosocereus gounellei* (F.A.C. Weber) Byles & Rowley) is used as cattle feed, but this practice is absent in Feirinha despite some traces of drylands. Ravines were defined by one farmer as “a mouth of forest at the foot of the hills,” and contain shrubby trees. These areas are preferred by farmers for cattle grazing, as they host species that provide fruits for feeding cattle, such as biriba (*Terminalia corrugata* (Ducke) Gere & Boatwr) and maniçoba (*Manihot caerulescens* Pohl). Lastly, the hills are pediplaned areas that are home to specific wild animal species, making them important for local hunting.

It is evident that these landscapes have been shaped over time by land use, management practices, and the preparation of plots for cultivation, and so they form environments where culture and nature are deeply intertwined. They reflect a productive and secure place for people to live in both space and time (Clement *et al.*, 2021).

3.2 INTER AND INTRASPECIFIC DIVERSITY IN THE STUDIED COMMUNITIES

In the context of managed plants, 80 cultivated species were recorded in productive areas, including croplands and homegardens (Table 1). The agrobiodiversity of peasant farmers comprises 21.25% native species from the Cerrado and Caatinga biomes.

Notable examples among the native species include assa peixe (*Vernonanthura brasiliiana* (L.) H. Rob.), used to treat bronchitis and pneumonia, and umbu (*Spondias tuberosa*) fruit, consumed as food in the Caatinga region. Several exotic species are also cultivated in homegardens, such as jamelão (*Syzygium jambolanum*) and pomegranate (*Punica granatum* L.).

As observed in other studies (Sanfilippo *et al.*, 2021; Santana *et al.*, 2023), the greatest richness of cultivated species is concentrated in productive homegardens (Table 1), which are predominantly managed by women, emphasising their central role in safeguarding agrobiodiversity. On the other hand, the diversity of crops grown in croplands, which include maize, beans, squash, melon, and cassava, among others, represents a predominantly male-driven activity.

Table 1 – Cultivated and collected plants in the studied communities.

Popular name	Scientific name	Family	Planting location	Uses
Abacate	<i>Persea americana</i> Mill.	Lauraceae Lauraceae	Hg	F
Abacaxi	<i>Ananas comosus</i> (L.) Merril	Bromeliaceae	Hg, Se	F
Abóbora	<i>Cucurbita moschata</i> Duchesne	Cucurbitaceae	Hg, Pl, Ll, Fp, Wl	F
Açafrão	<i>Curcuma alismatifolia</i> Gagnep.	Zingiberaceae	Hg, Ll	F, M
Acerola	<i>Malpighia glabra</i> L.	Malpighiaceae	Hg	F, M
Agrião	<i>Rorippa nasturtium-aquaticum</i> (L.) Hayek	Brassicaceae	Hg	F
Alecrim	<i>Salvia rosmarinoides</i> A.St.-Hil. ex Benth.	Lamiaceae	Hg	M
Alface	<i>Lactuca sativa</i> L.	Asteraceae	Hg	F

Popular name	Scientific name	Family	Planting location	Uses
Algodão	<i>Gossypium sp</i>	Malvaceae	Hg	M
Amora	<i>Morus nigra L</i>	Moraceae	Hg	F, M
Araçá	<i>Psidium cattleianum Sabine</i>	Myrtaceae	Hg	F
Arroz	<i>Oryza sativa L</i>	Oryzoideae Poaceae	LI; Fp; WI; Se	F, Af, Ad
Assa-peixe	<i>Vernonanthura brasiliiana (L.) H.Rob</i>	Asteraceae	Hg	M
Babosa	<i>Aloe arborescens Mill.</i>	Asparagaceae	Hg	M
Bambu	<i>Bambusa bambos (L.) Voss</i>	Poaceae	Hg	Art
Banana	<i>Musa paradisiaca L. (var. Musa acuminata Colla)</i>	Musaceae	Hg, LI, WI, Fp	F, M, Ad, Af
Batata-doce	<i>Ipomoea batatas (L.) Lam</i>	Convolvulaceae	Hg, LI, Fp	F
Berinjela	" <i>Solanum mammosum L</i> "	Solanaceae	Hg	F
Boldo	<i>Plectranthus cf. barbatus Andr.</i>	Lamiaceae	Hg	M
Bugarinho	<i>Jasminum sambac. (L.) Aiton</i>	Oleaceae	Hg	OR
Cabaça	<i>Lagenaria siceraria (Molina) Standl</i>	Cucurbitaceae	Hg	Art
Cabeça-de-fraldeia	<i>Melocactus bahiensis (Britton & Rose) Luetzelb.</i>	Cactaceae	Hg	OR
Caju	<i>Anacardium occidentale L.</i>	Anacardiaceae	Hg, PI, LI, Fp, WI	F, M, Ad, Af
Capim forragens	<i>Cymbopogon sp</i>	Poaceae	Hg, PI LI; Fp, WI	M, Af
Cana-de-açúcar	<i>Saccharum officinarum L.</i>	Poaceae	Hg, LI, Fp	A, Af
Canela	<i>Cinnamomum verum J.Presl</i>	Lauraceae	Hg	M
Cebolinha	<i>Allium fistulosum L.</i>	Amaryllidaceae	Hg	F, M
Coco	<i>Cocos nucifera L.</i>	Arecaceae	Hg	F, M
Coentro	<i>Coriandrum sativum L.</i>	Apiaceae	Hg	M
Coité	<i>Crescentia cujete L.</i>	Bignoniaceae	Hg	Art
Coronha	<i>Macropsychanthus violaceus (Mart. ex Benth.) L.P.Queiroz & Snak</i>	Fabaceae	Hg	Spiritual
Erva-doce	<i>Pimpinella anisum L.</i>	Apiaceae	Hg	M
Erva-cidreira	<i>Melissa officinalis L.</i>	Lamiaceae	Hg, LI, Fp	M
Eucalipto	<i>Eucalyptus sp</i>	Eucalipteae Myrtaceae	Hg	M
Fava	<i>Phaseolus lunatus L.</i>	Fabaceae	LI	F, Ad, \$, Af
Feijão de corda	<i>Vigna unguiculata (L.) Walp.</i>	Fabaceae	Hg, LI, PI, WI, Fp, Se	F, M, Af, \$, IN, Ad
Folha Santa	<i>Kalanchoe pinnata (Lam.) Pers</i>	Crassulaceae	Hg	M
Fumo	<i>Nicotiana tabacum L.</i>	Solanaceae	Hg	F, IN
Gengibre	<i>Zingiber officinale Roscoe</i>	Zingiberaceae	Hg	M
Gergelim	<i>Sesamum indicum L.</i>	Pedaliaceae	Hg, PI, LI, WI, Fp	IN, F, Af, M
Goiaba	<i>Psidium guajava L.</i>	Myrtaceae	Hg, LI, Fp, Se	F, M, Af
Graviola	<i>Annona muricata L.</i>	Annonaceae	Hg	F
Hortelã	<i>Mentha spicata L.</i>	Lamiaceae	Q	M
Inhame	<i>Colocasia esculenta (L.) Schott</i>	Araceae	Hg, LI, PI	F
Jamelão	<i>Syzygium cumini (L.) Skeels</i>	Myrtaceae	Hg	F, M
Laranja	<i>Citrus sinenses (L.) Osbeck</i>	Rutaceae	Hg, LI, Fp, WI	F, M, Ad
Lima	<i>Citrus sp.</i>	Rutaceae	Hg, LI, Fp, WI	F, M, Ad

Popular name	Scientific name	Family	Planting location	Uses
Limão	<i>Citrus ×limon (L.) Osbeck</i>	Rutaceae	Hg, LI, PI, WI	F, M
Malva-do-Reino	<i>Plectranthus amboinicus (Lour.) Spreng.</i>	Lamiaceae	Hg	F
Mamão	<i>Carica papaya L.</i>	Caricaceae	Hg, LI, VE	F, M, Af
Mandioca	<i>Manihot esculenta Crantz</i>	Euphorbiaceae	Hg, PI	F, Af
Manga	<i>Mangifera indica L.</i>	Anacardiaceae	Q, PI, Fp, LI, Se	F, M, Ad
Maracujá	<i>Passiflora sp</i>	Passifloraceae	Hg	F, M
Maravilha	<i>Mirabilis jalapa L.</i>	Nyctaginaceae	Hg	OR
Mastruz	<i>Dysphania ambrosioides (L.) Mosyakin & Clemants.</i>	Chenopodiaceae Amaranthaceae	Hg	M
Maxixe	<i>Cucumis anguria L.</i>	Cucurbitaceae	Hg, LI, Fp, PI	F
Milho	<i>Zea mays L.</i>	Poaceae	Hg, LI, Fp, PI, VE	F, M, IN, Af, Ad
Mimo do céu	<i>Antigonon leptopus Hook. & Arn</i>	Polygonaceae	Hg	OR
Melancia	<i>Citrullus lanatus (Thunb.) Matsum. & Nakai</i>	Cucurbitaceae	Hg, LI, PI, VA	F, IN, Ad, Fa
Melão	<i>Cucumis melo L.</i>	Cucurbitaceae	Hg, LI, PI, Fp	F, IN, Ad, Af, Ad
Meloa	<i>Cucumis melo L. × momordica</i>	Cucurbitaceae	Hg, LI, PI, Fp	F, IN, Ad, Af, Ad
Ninho	<i>Azadirachta indica A.Juss.</i>	Meliaceae	Hg	IN
Ora-pro-nobis	<i>Pereskia aculeata Mill.</i>	Cactaceae Juss	Hg	M
Palma	<i>Opuntia ficus-indica (L.) Mill.</i>	Cactaceae	Hg	Af
Piã	<i>Jatropha mollissima (Pohl) Baill.</i>	Euphorbiaceae	Hg	M, Spiritual
Pimenta	<i>Capsicum sp.</i>	Solanaceae	Hg, LI, WI	IN, Ad, A, M
Pimenta de Macaco	<i>Xylopia aromatica (Lam.) Mar</i>	Annonaceae Juss	Q	M
Pinha	<i>Annona squamosa L</i>	Annonaceae Juss	Hg	F
Pitanga	<i>Eugenia uniflora L.</i>	Myrtaceae Juss.	Hg	F
Quiabo	<i>Abelmoschus esculentus (L.) Moench</i>	Malvaceae Juss	Hg, LI	F
Romã	<i>Punica granatum L.</i>	Punicaceae Lythraceae	Hg	M
Rosa do deserto	<i>Adenium obesum (Forssk.) Roem. & Schult.</i>	Apocynaceae Juss	Hg	OR
Seriguela	<i>Spondias purpurea L.</i>	Anacardiaceae	Hg	F, Af
Tamarindo	<i>Tamarindus indica L.</i>	Fabaceae	Hg	F
Tangerina	<i>Citrus spp.</i>	Rutaceae	Hg	F
Terramicina	<i>Alternanthera brasiliana (L.) Kuntze</i>	Amaranthaceae	Hg	M
Tomate	<i>Solanum lycopersicum L.</i>	Solanaceae	Hg, Fp	F
Umbú	<i>Spondias tuberosa L Arruda</i>	Anacardiaceae	Hg	F
Urucum	<i>Bixa orellana L.</i>	Bixaceae	Hg	F
Vinagreiro	<i>Hibiscus Sabdariffa L.</i>	Malvaceae	Hg	F

Legend: **Uses:** F = Food; M = Medicinal; C = Condiment; Ad = Fertilizer; Af = Animal feed; Art = Handcraft; OR = Ornamental; IN = Insecticide. **Planting Locations:** Hg = Home garden; PI = Plateau; LI = Lowland; WI = Wetland; Fp = Floodplain; Se = Swamp edge.

Source: The authors.

At least 24 of the managed plant species were recorded with more than one intraspecific variant, with the most diverse ethnovarieties found among species of fava beans, bananas, rice, beans, and maize (Table 2).

Table 2 – Ethnovarieties of cultivated species in croplands and homegardens

Popular name	Scientific name	Family	Ethnovarieties	N
Capim forragem	<i>Cymbopogon sp</i>	Poaceae	"Capim santo" " <i>Andropogon</i> " "momaça" "Baiuiara" "mandante" "pangola" "Capim estrela"	7
Fava	<i>Phaseolus lunatus L.</i>	Fabaceae	Fava roxa", Fava branca", "Fava pintada", "listadinha", "fava preta" "fava timbó", "fava vermelha"	7
Banana	<i>Musa spp.</i>	Musaceae	"Maçã", "Três Quintaluina", "Cachiola" "Prata", "Baixãonana d'água" "Baixãonana roxa" "marmelo"	7
Milho	<i>Zea mays L.</i>	Poaceae	"Tardão:"Cunha", "MangaBaixão", "Milho Branco" Ligeirinho:"ligeiro", "híbrido", "transgênico", "safrinha"	7
Arroz	<i>Oryza sativa L.</i>	Poaceae	"Capim"; "Maranhão vermelho"; "Maranhão branco"; "Mangaba Baixão"; "Saia velha".	5
Feijão de corda	<i>Vigna unguiculata (L.) Walp.</i>	Fabaceae	Sempre verde", "pitiu", "feijão vinagre" "feijão de corda", "rabo de pe"	5
Melancia	<i>Citrullus lanatus (Thunb.) Matsum. & Nakai</i>	Cucurbitaceae	"buscapê", "japonesa", "comum", "projeto"	4
Manga	<i>Mangifera indica L.</i>	Anacardiaceae	"Espada" "Sumo" "roxa" "manguita"	4
Mandioca mansa	<i>Manihot esculenta Crantz</i>	Euphorbiaceae	"manteiguinha", "cacau", "serrana", "mão de onça" "pé de pombo",	4
Laranja	<i>Citrus sinenses (L.) Osbeck</i>	Rutaceae	"Laranja gigante", "Laranja comum", "Laranja da terra"	3
Limão	<i>Citrus xlimon (L.) Osbeck</i>	Rutaceae	Limão galego", "Limão comum, "Limão pocã"	3
Gergelim	<i>Sesamum indicum L.</i>	Pedaliaceae	"Gergelim Branco" "Gergelim preto"	2
Goiaba	<i>Psidium guajava L.</i>	Myrtaceae	"Goiaba Branca", "Goiaba vermelha"	2
Lima	<i>Citrus sp.</i>	Rutaceae	"Lima comum", "Lima rosa"	2
Melão	<i>Cucumis melo L.</i>	Cucurbitaceae	"Melão-abóbora", "melão-rei"	2
Mamão	<i>Carica papaya L.</i>	Caricaceae	"Papaia", "mamão- macho"	2
Pitanga	<i>Eugenia uniflora L.</i>	Myrtaceae Juss.	"Pitanga Amarela", "Pitanga Vermelha"	2
Meloa	<i>Cucumis melo L. x momordica</i>	Cucurbitaceae	Amarela", "rajada"	2
Araçá	<i>Psidium cattleianum Sabine</i>	Myrtaceae	Araçá de Vazante, Araçá de Baixão	2
Mandioca brava	<i>Manihot esculenta Crantz</i>	Euphorbiaceae	"Babuzinha" "Baixa preta"	2
Abóbora	<i>Cucurbita moschata Duchesne</i>	Cucurbitaceae	Jerimum", "Casco de Jacaré"	2
Quiabo	<i>Abelmoschus esculentus (L.) Moench</i>	Malvaceae	peludo, liso	2

Source: The authors.

The maintenance of inter and intraspecific agrobiodiversity, particularly in introduced plant species, has significant positive impacts on food and nutritional security (Cleveland *et al.*, 1994; Santilli, 2009), contributing to the relative autonomy of rural communities (Fernandes, 2012). Ove and Spaner (2007) emphasise that this agricultural diversity is essential for ecological resilience, food security, and the sustainability of agroecosystems.

For instance, farmers preserve seeds from “quick” crop varieties of rice, maize, and beans, meaning those maturing within a shorter period (March to April), and heirloom seeds referred to as “late” crops, which require longer cultivation periods (November to March). This diversity contributes to food security (Fernandes, 2012) by mitigating risks in case of crop failures. Additionally, using specific varieties ensures preservation of heirloom crops: “We have the tradition of planting mangaba maize alongside other varieties. They say planting it with black maize prevents crop loss” (Interviewee 6, Mocambo Community, 2023).

Traditional seed management practices play a critical role in maintaining biological diversity and fostering resilient and sustainable agricultural systems. Bevilaqua *et al.* (2014) highlight the role of seed-keeper farmers in preserving local varieties and expanding agrobiodiversity, emphasising the contribution of these practices to environmental resilience and food security in rural communities. Similarly, Coomes *et al.* (2015) argue that seed networks are fundamental for genetic conservation, strengthening food sovereignty, and enabling crops to adapt to climate change.

The adaptation of agroecosystem practices to local ecological diversity is evident in different preferences among communities. For example, interviewees from Feirinha showed greater interest in conserving “capim rice,” better adapted to floodplain regions. In contrast, farmers from Mocambo preferred “mangaba rice,” more suited to lowland soils. Farmers also noted distinctions in the genetic varieties of fava beans, typically grown in lowlands rather than floodplains or upland plateaus. Sandy soils are more suitable for purple and yellow fava varieties, which are less bitter. This cultivation is rare in Feirinha, but common in Mocambo.

Farmers experiment with, maintain, and select intraspecific varieties using strategies that ensure ecological function and adaptation within agroecosystems. For example, one farmer justified selecting sugarcane varieties based on sweetness and drought resistance. However, the lack of resources for processing impacts the conservation of cassava varieties, categorised as “sweet” or “bitter.” The existence of a processing facility in Mocambo supports using the bitter variety “*babuzinha*,” while Feirinha farmers show little interest in such varieties due to the absence of processing means.

Intraspecific diversity also generates new varieties through natural hybridisation, contributing to cultural and ecological resilience. This dynamic is observed in crops such as heirloom maize (e.g., mangaba, yellow, wedge-shaped, black), squash (green or yellow-skinned, neck squash), and fava beans (black, white, red). Farmers highly value seeds and employ diverse agroecological strategies for their conservation. For instance, maize and rice seeds are stored by hanging them, with the husk playing a critical protective role. Rice seeds are often stored above wood stoves, where heat prevents pest infestation, while bean seeds are buried in sand, barrels, or plastic bottles. Additionally, familial and neighbourly networks support seed exchanges and help maintain diversity in case of loss.

Beyond plants, 11 domesticated animal species were recorded, providing food and family supplies or indirectly contributing to agroecosystem maintenance. As Hart (1985) noted, interactions between plant and animal species enhance agrobiodiversity abundance. For example, intensive cattle farming occurs from May to October near floodplains and upland pastures with grasses such as *Andropogon*.

Farmers also emphasise the varietal importance of domestic animals. The “Índio” breed of poultry is valued for its disease resistance, while the “Polar” breed fattens quickly for consumption. Additionally, *granja* chickens are favoured for their higher egg production, supporting both household consumption and surplus.

Maintaining intraspecific varieties generates abundant agrobiodiversity within the reciprocal nature-culture relationship of agroecosystems. As expressed by Zé Pinto in the song *Caminhos Alternativos*: “We cultivate the land, and it cultivates us,” reflecting the co-evolution of land and knowledge (Caporal; Azevedo, 2011). Agroecosystems rely on local practices and knowledge, playing a central role in conserving genetic reservoirs and maintaining their diversity (Emperaire, 2020, p. 19).

3.3 INTERACTIONS BETWEEN BIOLOGICAL AND CULTURAL DIVERSITY

Cultivated plants serve multiple purposes in peasant agroecosystems, including supporting equine and bovine rearing. These animals function as transportation and assist in managing cattle herds, which are not only a long-term savings mechanism for farmers but also contribute essential services to the agroecosystem, such as milk production and manure provision (Silva, 2021). The multifunctional knowledge of species’ use and management plays a vital role in ensuring agrobiodiversity security within these systems (Cajado *et al.*, 2017; Hart, 1985).

Peasant farmers use plants from the plateau and Caatinga biomes for various applications, highlighting their deep knowledge of local biodiversity. For example, they prepare medicinal infusions from species like the bark of *Brosimum gaudichaudii* (bureré) and *Ximenia americana* (ameixa) for human and livestock treatments. The bark of *Albizia niopoides* (angico) is utilised for tanning cattle leather post-slaughter, which is later used to craft saddles for equine activities. Honey extraction not only provides food for family consumption but also yields wax, an essential source of lighting. The bark of *Magonia pubescens* (timbó) from the plateaus is employed as an alternative to chemical fly repellents sold in agricultural supply stores. When combined with *Sapindus saponaria* (soapberry tree), *Mauritia flexuosa* (buriti palm) fibres, and other local plants, these resources are transformed into traditional products such as soap, brooms, oil, and artisanal tools.

In terms of agricultural practices (know-how), fertilization techniques were observed to enhance soil fertility. These include using crop residues from previous harvests and cattle manure, which is consistent with other studies (Cajado *et al.*, 2011; Gliessman, 2002; Silva, 2021).

Intercropping is another widely employed technique. Examples include maize with beans and rice; *Andropogon* grass with maize; maize, beans, and pumpkin; and maize, fava beans, and pumpkin. These combinations contribute to reducing soil erosion, enriching soil fertility, optimizing human labour, and decreasing pest incidence. Moreover, intercropping ensures the abundance of agricultural varieties, promoting biodiversity.

Additional techniques include crop rotation, which allows soil to rest and disrupts pest life cycles; and the strategic use of sesame plants as a natural barrier against pests, particularly leaf-cutting ants. These practices demonstrate the resourcefulness and resilience of peasant farmers to sustainably manage their agroecosystems.

3.4 THE IMPACTS OF AGRIBUSINESS ON PEASANT AGROBIODIVERSITY

Peasant farmers exhibit a dual response to the impacts of agribusiness, alternating between resistance and adaptation. Resistance is demonstrated through the continuous application of agroecological practices, such as intercropping, crop rotation, species diversity management, heirloom seed conservation, and cultural practices, including pest control prayers and planting aligned with lunar phases. Adaptation is observed by integrating certain agribusiness elements into traditional practices, such as the use of soybeans as cattle feed. Nevertheless, the monoculture-based agricultural model, characterised by cultivating transgenic crops and applying agrochemicals, has contributed to the loss of heirloom seed varieties and abandonment of traditional farming practices.

The Feirinha community has experienced a decline in inter- and intraspecific diversity over the past decade, with crops such as yam (*Colocasia esculenta* (L.) Schott), local rice varieties (“arroz carioca” and “arroz ligeirinho”), and sugarcane (“piojota”) disappearing from certain agroecosystems. Additionally, some farmers have become integrated into agribusiness supply chains, either as wage labourers or through modifications to their agricultural practices (Sousa; Silva, 2021). Despite these changes, the use of agrochemicals remains uncommon and is largely avoided due to concerns over health risks. In fact, some farms have doubled daily wages and adopted preventive measures to address these concerns, such as using cattle milk as a protective agent against contamination.

Menezes and Silva (2024) highlight that agribusiness expansion in the Sergipe backlands of the Caatinga biome has significantly compromised the sociobiodiversity of the region. In contrast, traditional agroecological practices and knowledge systems demonstrate potential for developing more sustainable production models. Field data reveal that peasant agricultural knowledge embodies innovative processes derived from integrating traditional and modern practices and crop varieties. However, the dynamic conservation of agrobiodiversity is increasingly threatened by environmental degradation linked to soybean expansion (Eloy *et al.*, 2020).

Soybean monoculture expansion has accelerated deforestation in the plateau and Caatinga regions, leading to a loss of communal lands and associated practices, such as free-range livestock grazing and fruit collection from the Cerrado and Caatinga. Moreover, the construction of urban water supply reservoirs and intensified fishing activities have adversely affected fish diversity and availability. Violent land enclosures and territorial appropriations exacerbate the erosion of communal areas and crop genetic diversity. Similarly, Nogueira (2009) observed that Cerrado deforestation for eucalyptus plantations resulted in the expropriation of communal lands, with severe repercussions for the physical and social reproduction of *geraizeiros* in northern Minas Gerais.

Understanding how peasant farmers manage their agroecosystems is crucial for promoting a “productive praxis highly integrated with nature” (Carvalho, 2013, p. 1). These farmers play a vital role in conserving agrobiodiversity across four variable levels: biological diversity, genetic variability, ecological diversity, and the cultural diversity embedded in their territories (Santilli, 2009).

However, limited recognition of peasant livelihoods is partly attributed to the “scarcity of floristic and phytosociological studies in Cerrado-Caatinga ecotone areas in southern Piauí” (Macedo, 2018, p. 2). Peasant territoriality not only significantly contributes to the preservation of the Cerrado-Caatinga ecotone through associated traditional knowledge, but also through the broader socio-cultural connections to the land. These lands extend beyond the physical spaces of habitation and cultivation, encompassing extensive areas tied to affective relationships and the dynamic interactions of individuals, families, and kinship groups.

Finally, fostering dialogue between scientific and traditional knowledge is essential for strengthening agroecology as a framework for conserving the Cerrado-Caatinga ecotone (Souza; Freitas, 2021, p. 58). As Porto-Gonçalves (2019, p. 4) asserts, “The defence of a biome cannot be separated from the defence of the territories of the peoples who inhabit it, where its riches are conserved, nurtured, and multiplied.”

4 CONCLUSIONS

The Cerrado-Caatinga ecotone in the state of Piauí is an area of significant ecological and cultural value, recognised as a biodiversity hotspot. However, the expansion of agribusiness, particularly soybean monocultures, presents severe biocultural threats. These threats include deforestation of native vegetation and exclusion of communal territories (ecological impacts), as well as homogenisation of cultivated species (biological impacts).

Peasant farmers employ diverse strategies to conserve agrobiodiversity. Cultivation of high inter and intraspecific diversity in home gardens and agricultural fields contributes to food security and enhances local adaptability. Additionally, diversified agricultural practices, such as intercropping, crop rotation, and managing traditional seeds, along with utilising communal areas in the Cerrado and Caatinga (such as for harvesting native plants and free-range livestock grazing) support adaptive agroecosystem management. These practices reflect a co-evolutionary relationship between farmers and their environment, which is crucial for increasing the climate resilience of agroecosystems and ensuring food security in rural communities.

In the context of agribusiness expansion, farmers resist or adapt to the changes introduced by this model, including high-yield (transgenic) monocultures and the use of agrochemicals. This underscores the importance of preserving local knowledge by integrating traditional practices with scientific approaches, strengthening seed networks, and implementing other strategies to sustain agrobiodiversity. Such efforts are essential for safeguarding the territories and livelihoods of the peoples of the Cerrado and Caatinga, while simultaneously promoting sustainable agroecosystems and resilient rural communities.

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