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Agro and biodiversity in family farming: potential for diversification and conservation in deforested landscapes in Amazonia

Agro e biodiversidade na agricultura familiar: potencial de diversificação e conservação em paisagens desmatadas na Amazônia

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ABSTRACT: Biodiversity conservation, forest restoration and reduction of deforestation are urgent demands of Brazilian society. In the Portal da Amazônia, an agricultural frontier inserted in the Arc of Deforestation, there is an urgent need for strategies that guarantee agricultural production with the permanence of family farmers, allied to the reduction of deforestation and the conservation of agro and biodiversity. This research brings a multidisciplinary look at the agroforestry backyards in 19 communities in two counties. We identified the cultivated agricultural and forestry species, their main uses and potential for food production, diversification of production, income generation and use and conservation of native species in 44 backyards. We also worked with the spatialization of species richness, considering the landscapes of the two municipalities. We identified 201 species with several potential uses. Of these, 48% generate income from many market sources already established in the two counties. The choice of species to be cultivated (with high diversity, low similarity between backyards, frequent use of exclusive species and implementation of native forest species), combined with the potential use of these species for consumption and commercialization, denotes the importance of backyards for productive, food and income diversification for family farming. The wealth numbers and spatial distribution of the backyards show that diversification at the local scale (rural property) implies diversification at the regional scale (county). The results indicate acceptance of the model as a production system, in addition to the simplified systems usually used in deforested areas of the Amazon. One can point them as biodiverse spaces by decision of their maintainers, who diversify the production, favor the conservation of native forest species and contribute to the development and conservation of agro and biodiversity in the region. We conclude that they can be implemented as new productive systems in Portal da Amazônia, contributing to local and regional development, generating ecological, economic

and social benefits.

Keywords: rural communities; agroforestry backyards; landscape improvement; local and regional development.

RESUMO: Conservação da biodiversidade, restauração florestal e redução do desmatamento são demandas prementes da sociedade brasileira. No Portal da Amazônia, fronteira agrícola inserida no Arco do Desmatamento, são urgentes estratégias que garantam produção agrícola com permanência de agricultores familiares, aliadas à redução do desmatamento e conservação da agro e biodiversidade. Esta pesquisa traz um olhar multidisciplinar para os quintais agroflorestais, em 19 comunidades, em dois municípios. Identificamos as espécies agrícolas e florestais cultivadas, seus principais usos e potenciais para produção de alimentos, diversificação da produção, geração de renda e uso e conservação de espécies florestais nativas em 44 quintais. Trabalhamos também com a espacialização da riqueza de espécies, pensando a paisagem dos dois municípios. Foram identificadas 201 espécies, com diversos usos potenciais. Dessas, 48% geram renda a partir de várias fontes de comercialização já estabelecidas, nos dois municípios. A escolha de espécies a serem cultivadas (com alta diversidade, baixa similaridade entre quintais, uso frequente de espécies exclusivas e implantação de espécies florestais nativas), aliada ao potencial uso dessas espécies para consumo e comercialização, denotam a importância dos quintais para a diversificação produtiva, alimentar e de renda para a agricultura familiar. Os números de riqueza e a distribuição espacial dos quintais demonstram que a diversificação em escala local (propriedade rural) implica em diversificação na escala regional (município). Os resultados indicam aceitação do modelo como sistema de produção, para além dos sistemas simplificados usuais em áreas desmatadas da Amazônia. Pode-se apontá-los como espaços biodiversos por decisão de seus mantenedores, que diversificam a produção, favorecem a conservação de espécies florestais nativas e contribuem para o desenvolvimento e conservação da agro e biodiversidade na região. Conclui-se que podem ser implementados como novos sistemas produtivos no Portal da Amazônia, contribuindo para o desenvolvimento local e regional, gerando benefícios ecológicos, econômicos e sociais.

Palavras-chave: comunidades rurais; quintais agroflorestais; melhoria da paisagem; desenvolvimento local e regional.

1. Introduction

The Brazilian landscape[1] allows for the development and deployment of diverse production systems and models, from the simplest to the most complex and heterogeneous. A systemic approach to the planning and understanding of this landscape allows us to consider all the relationships between the different elements that compose it and the insertion of the human component in social, cultural, and economic matters and the policies associated with natural resource management models. Such ma-

[1] The term "landscape", used in this text, is comparable to the term "cultural landscape" used by the United Nations Organization (UNESCO) in its document "Operational Guidelines for the Implementation of the World Heritage Convention", in which cultural landscapes are considered cultural assets that represent the works of man associated with nature; thus, these landscapes reflect the evolution of human communities based on the physical influences of the natural environment. Still according to the document, cultural landscapes represent the various forms of sustainable use of land and are of great importance to protect these landscapes in order to contribute for the continuity of this type of use to maintain the natural value of the landscape (UNESCO, 2017).

nagement must combine, necessarily, agricultural production and the generation of employment and income with the conservation and maintenance of biodiversity and other natural resources.

In tropical regions, there are many types of agroecosystems[2] since they respond to the use by human populations. These ecosystems include, by definition, the people and their organizations, as well as the agrobiodiversity they use and manage for their livelihood and wellbeing (Chirwa & Mala, 2016) in several landscapes.

In theory, any action that introduces greater diversity in these agricultural systems and landscapes helps mitigate the negative impacts of productive activities and reduce the risks for rural producers in a reality of constant changes (Gliessman, 2009; Altieri *et al.*, 2015). The diversification consists of a strategy of adaptation and reduction of risks also for family agriculture (Simonetti *et al.*, 2013; Maciel *et al.*, 2018) in the face of the multiple pressures and challenges faced by this group (Noronha & Falcón, 2018).

To Deponti (2014):

> The importance of family agriculture to rural/regional development goes far beyond food production (...) Its recognition as a social form of labor and production, organized in a social, economical, productive and environmental way, under the aegis of territorial diversity and its several mechanisms of perpetuation, translates it as a rural/regional development strategy. (Deponti, 2014, p 12).

Still, for the author:

> The understanding of development as a process of social change that is multilevel (local, municipal, regional, state, and federal), multi-player (state, social movements, civil society), multi-institutional (market, public policies, traditions, rules), and multidimensional (social, economic, cultural, and environmental) highlights the role of social players, and, in this sense, considering the rural environment, family farmers deserve special attention. (Deponti, 2014, p.11)

In the context of family agriculture, diversification as production is pointed out by several authors. Simioni *et al.* (2016) identified the diversification of activities on the property as a strategy for improving the family income of farmers. For Vielmo *et al.* (2018), three types of practices (pluriactivity, diversification of production, and organic farming) combined contributed, in their research, for generating income and providing economic-financial stability for families. Schneider and Niederle (2010) identified innovations in the work and production processes of family farmers seeking greater autonomy, such as the development of pluriactivity and the search for alternative markets.

The implementation of Agroforestry Systems (AFSs) can, in theory, make up one of the strategies. The diversification promoted by these systems (involving multiple possibilities of combinations for intercropping trees, pasture and agricultural crops) potentially generates environmental, economic, and social benefits for the populations that cultivate them and improves the quality of the landscapes where they are based. They are actually pointed out as strategies to strengthen the resilience of family

[2] Ecosystems changed by human activity for agricultural development (Gliessman, 2009).

agriculture in agricultural landscapes (Oliveira *et al.* 2021).

The AFSs contribute to the conservation of agrobiodiversity in agricultural areas (Eichemberg & Amorozo, 2013) since they hold a great variety of species and usually value the use of native species (Oliveira Junior *et al.*, 2018). Among them, the agroforestry backyards (production spaces deployed near residences, with a biodiverse and multistrata structure) allow growing and managing species (forestry, fruit, logging, agricultural and livestock) for various uses (Amaral & Guarim Neto, 2008; Siviero *et al.*, 2011; Oliveira Junior & Cabreira, 2012; Quaresma *et al.*, 2015).

These spaces have been considered efficient alternatives to promote family-based agriculture (Neves, 2013) since they can generate new means of livelihood (Sedâmi *et al.*, 2017), increase income, and supplement the diet (Okonoski & Nabozny, 2009; Abebe *et al.*, 2010; Almeida & Gama, 2014; Flores *et al.*, 2016). They have also been characterized as multifunctional practices for the use of land given its potential for mitigating and adapting to climate change, developing ecosystem services, and minimizing threats to food and nutritional security (Galhena *et al.*, 2013; Mattson *et al.*, 2017).

In the context of degraded and deforested landscapes, the AFSs, in their most varied models, are considered a tool to restore landscapes and a valuable option of forest restoration in initiatives in which conventional restoration is not feasible (FAO, 2017). These systems can ensure the reintroduction of the arboreal and forestry components in landscapes where they are no longer present.

In this work, we focused on agroforestry backyards managed by family farmers in rural communities in Portal da Amazônia (MT), a region of agricultural borders and stage of many agrarian conflicts. It is assumed that by analyzing the importance of AFSs and, more specifically, of agroforestry backyards for food and income generation, it is possible to encourage their deployment and permanence in the social and environmental context of the area. In this sense, our goal was to characterize the agroforestry backyards deployed in rural communities of two municipalities, locating these spaces, identifying the main species cultivated and managed by family farmers, their main uses and potential for food production, diversification of production and conservation of native species, thinking of their deployment as a strategy for local and regional development

2. Material and methods

2.1. The regional context of Portal da Amazônia and target-municipalities for the study

The state of Mato Grosso is a striking example of the unequal relationship between large-scale conventional agriculture and family-based agriculture, with impacts on economic development and the environment since the colonization during the military regime, in the 1970s, and as the target of several policies - federal and state - of land occupation over the last 30 years (Olival *et al.*, 2016). The state was occupied by highly heterogeneous groups of people - workers seeking land ownership, colonization entrepreneurs, miners, loggers, and others (Schmink & Wood, 1992). As a result of this process, two large groups can be highlighted in relation to agriculture: migrants who occupied the central part of the state

and grew economically by producing soybeans, and those who went to more isolated areas, close to the remaining forest areas, and remained in precarious social and economic conditions (Olival *et al.* 2016). Both groups, based on different incentives, were responsible for a growing process of opening new areas for agricultural production, creating a scenario of degradation and fragmentation of the native forest ecosystems.

The environmental impacts of this process were diverse. Currently, the state of Mato Grosso has one of the highest rates of deforestation in Brazil (Vasconcelos et al., 2020) and is one of the leading states in the country in the use of pesticides and chemical fertilizers (Olival *et al.*, 2016).

Portal da Amazônia is part of a region under the influence of the BR-163 highway (Cuiabá--Santarém) and is composed of 16 municipalities, which originated from the occupation policies of the Mid-West and North Regions, developed mostly during the military period (Roboredo & Bergamasco, 2013). The region is characterized as an agricultural border with a history of conversion of native forest areas into extensive farming and livestock production (Weihs *et al.*, 2016). It is also located in the "Arc of Deforestation", where the advance of the agricultural border brought several impacts (Paul *et al.*, 2015), such as the loss of biodiversity and frequent agrarian conflicts, with strong pressure for new forest clearings. The current forest cover in the state of Mato Grosso is only 29% (IBGE, 2017), and in Portal da Amazônia (characterized by a mosaic with physiognomies of the Amazon Forest and Amazon-Cerrado Transition, according to Andrade (2007) is also degraded and fragmented - Figure 1).

In Portal da Amazônia, there is a strong influence of family agriculture, with over 84% of rural properties fitting into this category (Gervazio, 2015). Most of the communities were formed particularly by farmers from other regions of the country, who were, back then, participants of the colonization plans of the 1970s described here, and who came from a history of agrarian tension and lack of land in their regions of origin. The race for gold in the region also brought many migrants, and once the mining was over, many sought to establish themselves as farmers there (CEAAF, 2010).

Some historical features which led to the current profile of this segment in Portal da Amazônia were the difference in land quality between the land intended for public and private settlement projects, problems in the marketing of products derived from the main permanent crops, and the establishment of beef cattle and milk as the predominant activity among farmers (Olival, 2016). Recently, one more problem has emerged to be handled: the rapid spread of soy in the region (Bonini *et al.*, 2018).

It is in this context that the municipalities of Alta Floresta and Nova Canaã do Norte are inserted. Alta Floresta was founded in May 1979 based on a colonization project conceived by locals and southern settlers. It is located approximately 800 km from Cuiabá, the capital of the state, with an area of 8,982.8 km^2. Nova Canaã do Norte is located 716 km from Cuiabá and covers an area of 5,993 km^2. Its history features convoluted periods caused by the exploitation of rubber and mining (IBGE, 2017). The intensity with which the colonization process changed the soil coverage can be seen in Figure 2. In 36 years (between 1984 and 2020), the landscape with a predominance of native vegetation was cleared and transformed into a mosaic of different uses of land, with a predominance of pasture for dairy and beef cattle (Instituto Ouro Verde, personal

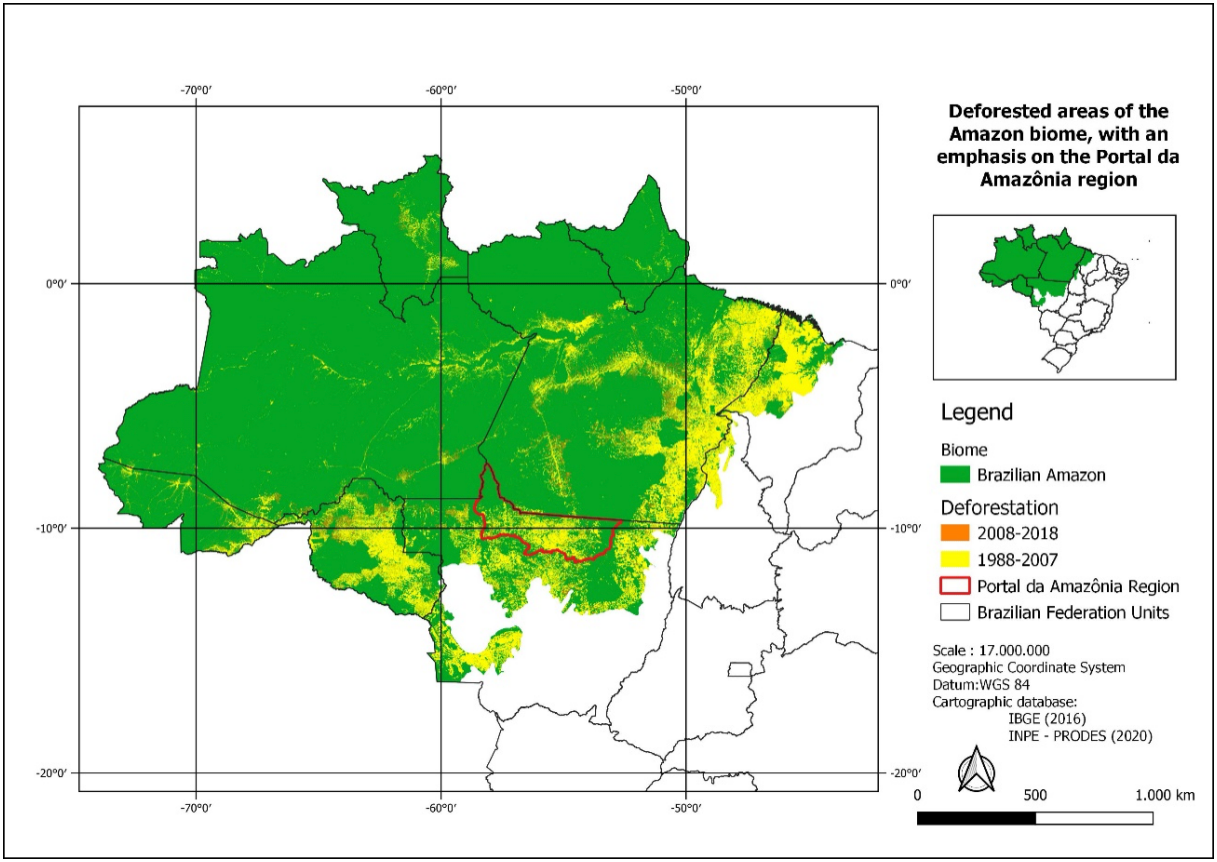
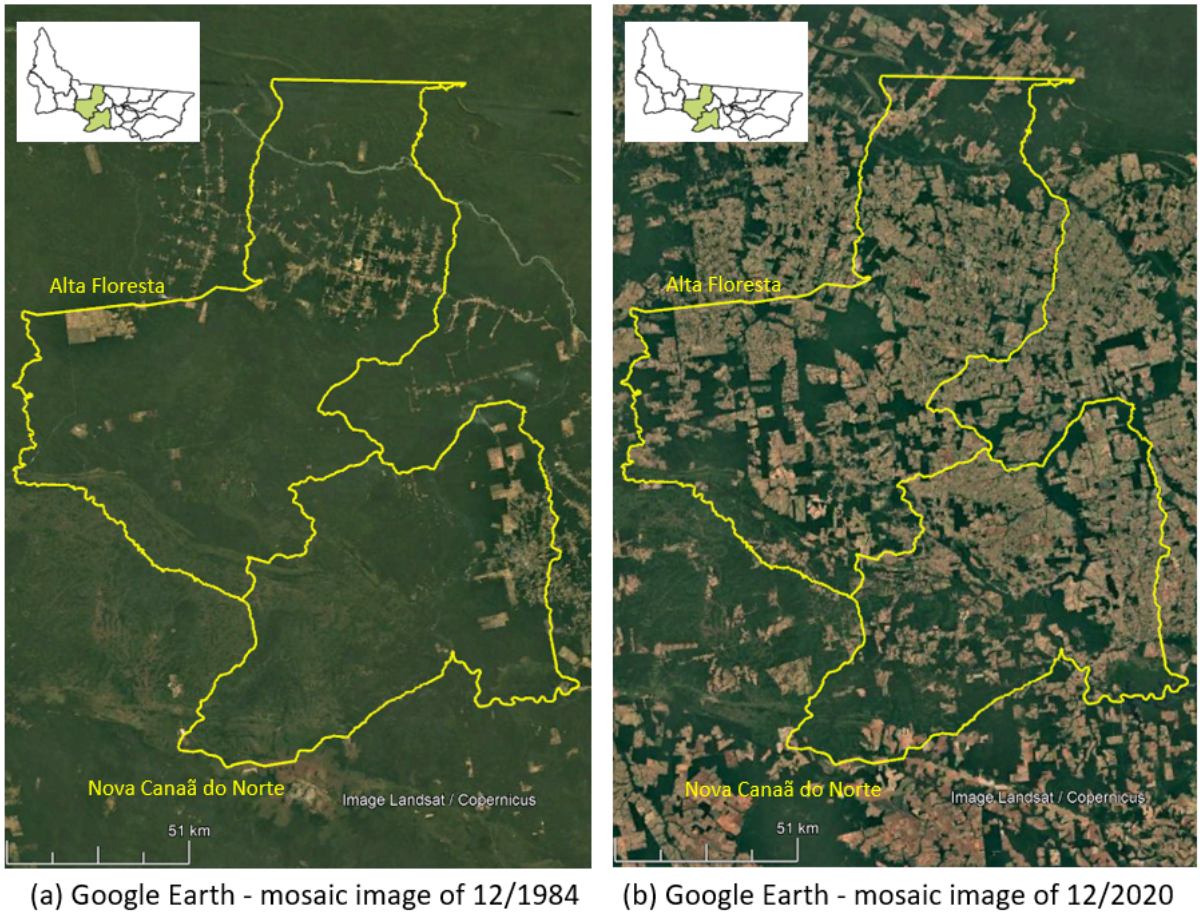


FIGURE 1 – Forest cover of the Amazon Biome, presenting the deforested areas in two historical periods (from 1988 to 2007 and from 2008 to 2018), with an emphasis on the Portal da Amazônia region.

SOURCE: Developed by the authors based on spatial databases from IBGE (2016) and INPE - PRODES (2020).

communication).

Both municipalities have areas serviced by *Projeto Sementes do Portal* (a project coordinated by the non-governmental organization *Instituto Ouro Verde*), which consists of a network of local farmers who collect and distribute seeds for the deployment of Agroforestry Systems (AFSs). Many of these farmers did not practice agriculture when they first arrived there. Currently, this practice is maintained by a significant number of players as a source of livelihood, although there are still some who do not have agriculture as their main activity and have paid jobs in cities (Instituto Ouro Verde, personal communication).



(a) Google Earth - mosaic image of 12/1984 (b) Google Earth - mosaic image of 12/2020

FIGURE 2 – Satellite Images of the evolution of soil coverage and use in the region show the replacement of native vegetation (dark green color) existing in 1984 by a mosaic of different land uses in 2020 in the region of the municipalities of Alta Floresta and Nova Canaã do Norte, located in the Portal da Amazônia territory, in the state of Mato Grosso.

SOURCE: Prepared by the authors using Google Earth with a municipal database from IBGE (2016).

2.2. History and description of the deployment of the backyards and the areas of study

Considering the scenario of environmental problems in the region of Portal da Amazônia which has already been described, there was a need for creating strategies to reduce the environmental impacts and allow the valuing of family agriculture, improvement of living conditions, and the generation of work and income for rural populations in this segment. In 2008, Instituto Ouro Verde (IOV) and social movements linked to Family Agriculture in

the region began planting initiatives for agroforestry systems, particularly for the restoration of areas of permanent preservation. One of the foundations for the deployment of these systems is a network of collection and distribution of forest seeds formed by the farmers themselves, which provides material for agroforestry, deployed primarily by direct seeding (*muvuca*), but also using the introduction of seedlings and seeds of annual crops, of green manure, of perennial crops, and of forestry as part of the "*Projeto Sementes do Portal*" (Portal Seeds Project, in a literal translation).

In 2010, the "*Centro de Pesquisa em Agrofloresta*" (Center for Research in Agroforestry, in a literal translation) was created, an initiative developed by Instituto Ouro Verde with support from the Royal Botanic Gardens and Kew, who initiated research efforts involving farmers and researchers from different universities with a focus in meeting demands in planning, planting and managing agroforestry systems. These efforts were supported by the Fundo Amazônia since 2013, which allowed the development of interdisciplinary research with training initiatives and the involvement of rural communities as part of the "*Programa de Pesquisa-Ação para avaliação e fortalecimento da Resiliência da Agricultura Familiar no Norte e Noroeste do Mato Grosso*" (Action-Research Program for Assessing and Strengthening the Resilience of Family Agriculture in the North and Northwest of Mato Grosso) (Instituto Ouro Verde, personal communication).

The AFSs models deployed include agroforestry backyards, multistrata agroforestry systems, and silvipastoral systems. The species used vary between properties since each farmer chooses the species they intend to deploy and manage based on the roles they will play in the system and, furthermore, in the production chains of interest.

Currently, in addition to the agroforestry systems, and as a result of this process, farmers also maintain other subsystems in their properties (Figure 3), besides the predominant monoculture of pasture for dairy cattle: fruit orchards, with a predominance of citrus, bananas, etc., the vegetable plots, where they grow cassava, corn, etc., gardens, usually attached to the AFSs, and woods - diverse plantations of trees, exotic and native species with several uses (Souza, 2019).

The focus of this study was agroforestry backyards deployed on properties of Alta Floresta and Nova Canaã do Norte from 2010 to 2016 with the initial goal of producing fruits, initially called agroforestry orchards.

We studied 44 backyards (Figure 4), 24 in Alta Floresta (AF) and 20 in Nova Canaã do Norte (NC), in the following rural communities: Guadalupe, Mundo Novo, São Francisco de Assis, São João Batista, São Mateus, São Pedro, Serra Verde, Terra Santa, and Vila Rural (in AF); and Boa Nova, Castanheira, Ibirarema, Monte Sinai, Monte Verde, Novo Caminho, Novo Paraíso, Rondon, São Camilo, São João Batista (in NC).

(a)

(b)

(c)

(d)

FIGURE 3 – Subsystems of agricultural production cultivated by family farmers in the study area.
LEGEND: (A) Agroforestry backyards; (b) Gardens; (c) Woods; (d) Vegetable plots, described by Souza, 2019.
SOURCE: Photos by Valdânia Conceição de Souza.

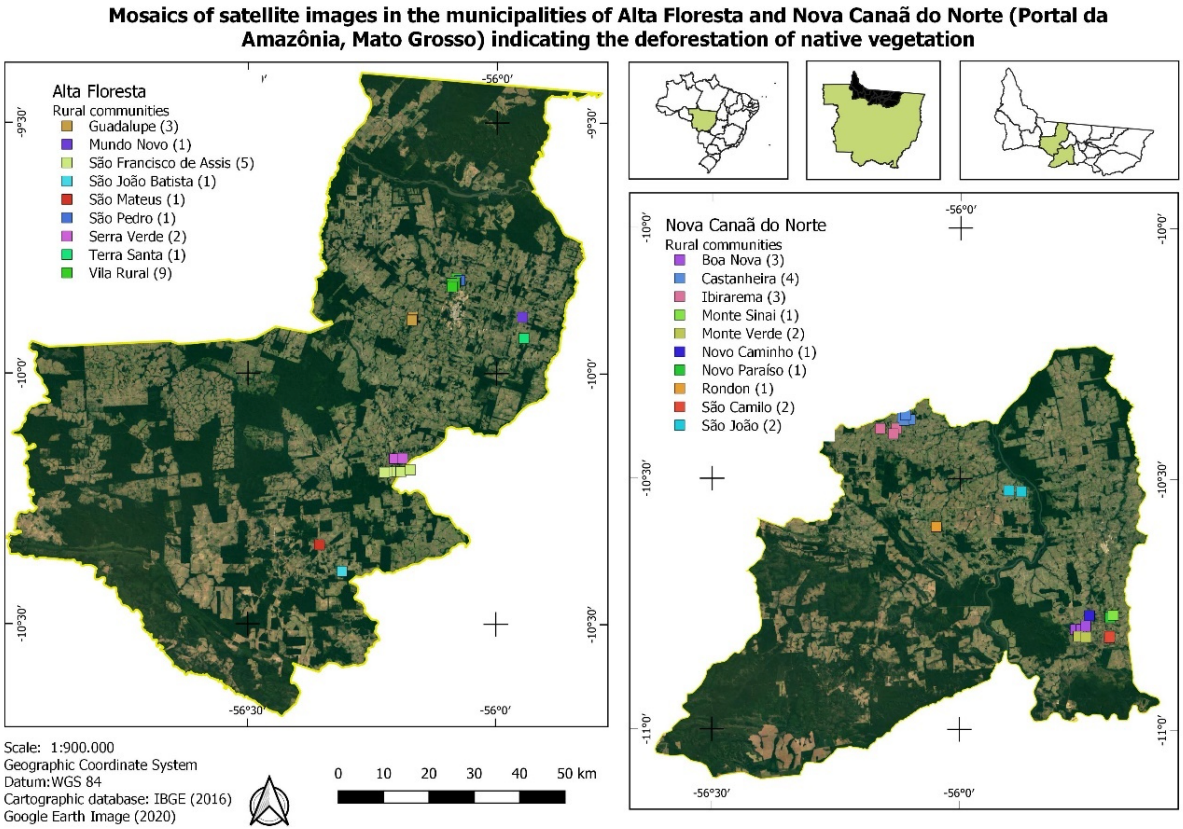


FIGURE 4 – Location of the Portal da Amazônia region (MT) and the municipalities of Alta Floresta and Nova Canaã do Norte represented in mosaics of satellite images indicating the deforestation of native vegetation, with emphasis on the 44 agroforestry backyards analyzed (different colors identify the 19 communities studied and the figure in parentheses indicate the number of the backyards studied in each community).

SOURCE: Developed by the authors based on spatial databases from IBGE (2016).

2.3. Methodology

The data were obtained through visits to the areas to identify and photograph the species and observe the structure of the backyard. These visits consisted in walking around the site, identifying the cultivated species by their common name.

The species were identified later using the lists available in Projeto Flora do Brasil 2020 (Brazil Flora Group, 2021) for native species and in The Plant List (2010) for exotic species. Then, they were categorized based on their habit (tree, shrub, herbaceous, or climbing), identifying the stratum they occupy in the AFS. In addition, we investigated the main uses recorded for these species by farmers in the region, the parts of the plant used, potential

forms of use (whether *in natura* or processed), and sources of marketing.

The full range of information was organized in electronic spreadsheets, and a complete list of the species cultivated in the backyards was drawn up, with their main characteristics. The data were analyzed based on descriptive statistics, and we estimated the species richness in each backyard and by the municipality. We also calculated the similarity between the crops, using the Jaccard Index (Ferreira Junior *et al.*, 2008) to help understand the differences in the preference of farmers when choosing the species to be grown in their backyards.

The location of the backyards was obtained through a Global Navigation Satellite System (GNSS). The points were plotted and associated with the number of species in each one of them. The spreadsheet was imported to the geographic information system QGIS, which enabled the drawing up of the thematic map with a graphical representation of the number of species in each yard.

3. Results and discussion

3.1. Agroforestry backyards as a source of diversification at a local and regional level

We found 201 species grown by farmers in the 44 backyards of the sample (the complete list of species can be found in Supplementary Material 1, organized by their botanical families and identified by their common and scientific names, with their respective information about potential uses, plant parts used, their habit of growth - related to the stratum that the plant occupies in the agroforestry system, and their occurrence per municipality).

The spatial distribution of backyards, as well as the number of species found in each one (Figures 5 and 6), demonstrate that diversification at a local level (rural property) also implies diversification at a regional level (municipality). These backyards, at the time of the analysis, are grouped, which is a result of the initiative by the *Instituto Ouro Verde* NGO and of the location of the properties of the farmers who joined the *Projeto Sementes do Portal.* However, based on the development of new initiatives or municipal public policies, and provided that other farmers from other communities are interested, this distribution can certainly be extended to the entire landscape.

As can be observed, the number of species varied greatly between backyards - with numbers between 12 and 98 species (Table 1) - and between municipalities (both their range and richness of species are much greater in Alta Floresta, as can be observed in Figure 7). The average richness found was 49 species per backyard.

The structure and composition characteristics of the backyards reflect their adequacy to the perception of each farmer about their space, as well as their preferences, needs, and desires (Carniello *et al.*, 2010; Siviero *et al.*, 2011). Surveys on the floristic composition and richness of agrobiodiversity in backyards of tropical regions around the world have shown a wealth of crops and the conservation of diversity in these spaces (Alcudia-Aguillar *et al.*, 2017). In Brazil (and in the Amazon), the studies by Quaresma *et al.* (2015), Gonçalves & Lucas (2017) and Almeida & Gama (2014) in Pará, and Amaral & Guarim Neto (2008), in the state of Mato Grosso, highlight agroforestry backyards as spaces of diversity.

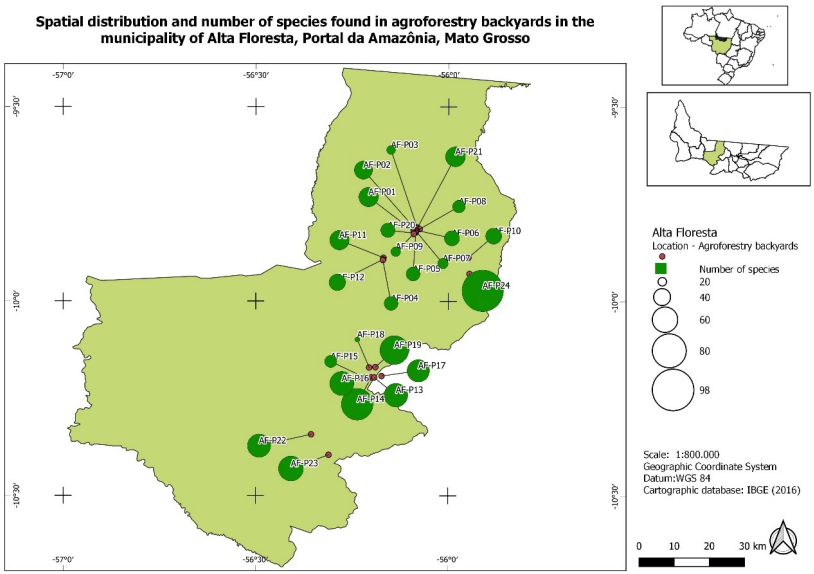


FIGURE 5 – Spatial distribution and number of species found in agroforestry backyards in the municipality of Alta Floresta, Portal da Amazônia, Mato Grosso.

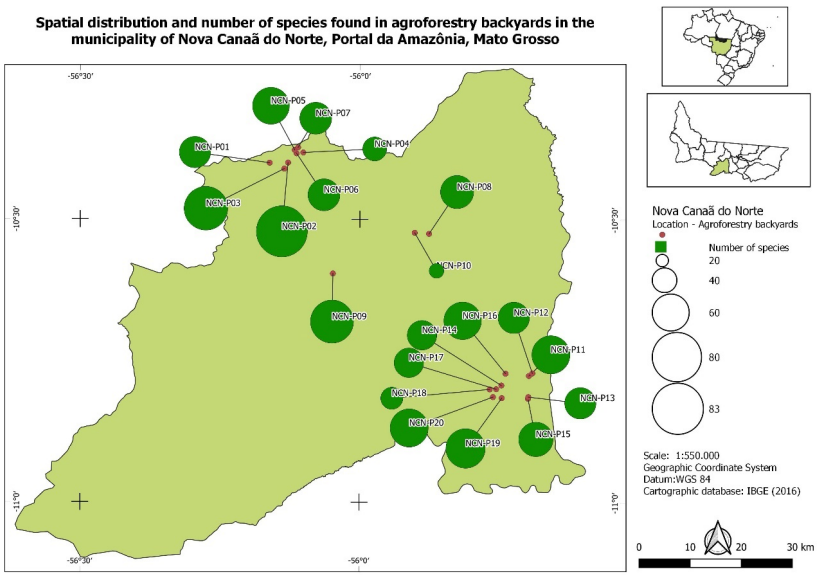


FIGURE 6 – Spatial distribution and number of species found in agroforestry backyards in the municipality of Nova Canaã do Norte, Portal da Amazônia, Mato Grosso.

The richness data found by this study suggest the backyards are spaces that can house a wide variety of plant species. Comparing them to the soil use system predominant in the region, i.e., dairy or beef cattle, which usually cultivates a single plant species (forage grasses, predominantly exotic, in most cases), the gain in diversity with the use of AFSs is demonstrably high.

TABLE 1 – General data of richness of species identified in the 44 agroforestry backyards in Alta Floresta and Nova Canaã do Norte (AFB = Agroforestry backyard).

	Alta Floresta	**Nova Canaã do Norte**
Richness of species	172	180
Minimum # of species found	12	24
Maximum # of species found	98	83
# of exclusive species	21	29
Average number of species per AFB	44	55

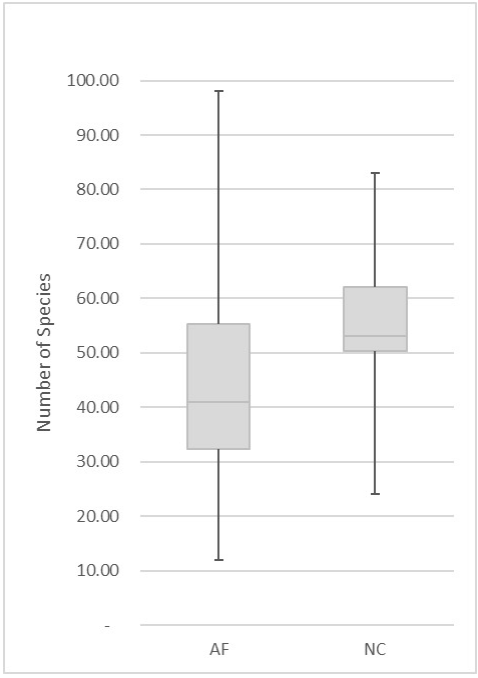


FIGURE 7 - Box-plot of the richness of species, per backyard, in the municipalities studied.
LEGEND: AF = Alta Floresta; NC = Nova Canaã do Norte.

3.2. The choice of species and their potential for use and marketing

The structure of AFSs refers to how the different species are distributed in the space, considering both horizontal and vertical stratification, including the distribution and organization of individuals in time and space. The occupation of the strata by different species denotes efficiency in the occupation of spaces (both horizontally and vertically, above and below ground) and in the use of resources (such as water, light, and nutrients), based on the intercropping of species with different life spans, growth speed, and architectures (considering the aerial part and root system). The spatial and temporal stratification of resources in AFSs has been considered an efficient strategy for soil use and occupation in rural properties.

In the crops maintained in backyards analyzed, we found species with different life cycles, from annual species to perennial crops (such as the arboreal species), occupying multiple strata. In the arboreal stratum, we found 54% (109) of the species, of which 46 are fruit trees and 56 have other uses, such as timber, firewood and shade, and ornamental. The remaining are bushes (27%), herbaceous species (16%) - with an emphasis on vegetables -, and vines (3%). Among the herbaceous species and bushes, many were acquired and introduced by the farmers independently and not as part of the supply of species and seedlings by *Projeto Sementes do Portal.*

The composition of species is quite variable, reflecting the preferences of cultivation of their keepers. The Jaccard Indexes calculated ranged from 0.11 to 0.53 in Alta Floresta and from 0.159 to 0.54 in Nova Canaã do Norte, and the similarity can be considered low (with indexes below 0.5) for most of the backyards. The average similarity between backyards was only 30% (assessed as low), considering all the backyards in both municipalities. In addition, many of the species cultivated are exclusive (only occur in one of the backyards studied). In Alta Floresta, 10% of the cultivated species are exclusive of a single backyard, and in Nova Canaã do Norte, the exclusive species correspond to 14% of the total. This demonstrates that the backyards serve the specific purposes and preferences of each family, based on their needs, history of life, and local conditions.

Cook *et al.* (2012) stress that the preferences determined by what the authors call the "residential managers", in addition to their social practices, include the systems that comprise the property. The authors also comment that these systems (which form a unique landscape in the property) are settings that correspond to the man-environment interactions, thus, adaptive and complex systems, which are related to their maintenance, whether it is planned/intentional or not.

It is important to highlight that the backyards studied are also areas of experimentation by the farmers. Not all cultivated species were provided by the project; many were introduced after the deployment of the backyard and have been observed by the managers regarding their establishment and growth in agroforestry intercrops. Such enrichment also reflects the acceptance and openness of farmers to AFSs as production systems in their lots. To Serrano-Ysunza *et al.*, (2017), the constant renewal of agrobiodiversity in tropical backyards is a reflex of the adaptation of rural families to the current rural environment, which seems to be true in the areas studied, considering the history of the region and the difficulties faced by family agriculture.

The deployment of AFSs is not characterized as a traditional activity in the Portal region (as in other regions of the Amazon) - i.e., it is not part of the local culture and the farmers involved in the project (based on information provided by the technicians of *Instituto Ouro Verde*) had no previous experience. The choice of species managed and the structure of these spaces is related to the profile of their managers - most of them migrants from other regions of the country - and the availability of seeds and seedlings supplied by *Projeto Sementes do Portal* and obtained by the farmers from elsewhere. To Henkel & Amaral (2008), economic reasons and social behavior, as well as previous experiences, influence the choice of cultivated species; the production and consumption choices are, oftentimes, culturally determined. This brings complexity to the choice of species, products and to agricultural management in each property.

To Deponti (2014):

> Productive diversity is associated with different strategies of social, economic, and cultural reproduction, with different social players that are interrelated (...) In contexts of rural/regional development, heterogeneity must be seen as a potentiality (Deponti, 2014, p. 12).

The intended use for each species is what determines, for the most part, their cultivation in areas of AFSs. Among the species identified, those with a dietary use appear in greater numbers (113 in total), followed by timber (56), and the other uses (Figure 8). The predominance of edible species in agroforestry backyards is common (Almeida & Gama, 2014; Coelho *et al.*, 2016; Garcia *et al.*, 2017; Pereira *et al.*, 2018) and was expected in these areas, which were initially deployed for fruit production.

It is worth mentioning that these food species, cultivated and managed within the AFSs, are consumed in the properties, which indicates a dietary enrichment, as a result of this production system, of the families. Most of these species (according to the extensionist technicians who follow-up on the farmers) were not cultivated or consumed in the communities prior to the deployment of the backyards.

The choice for multiple use species is also common in AFSs (Martin *et al.*, 2019); of the 201 species identified, 54 (27%) have the potential for use by farmers for more than one purpose.

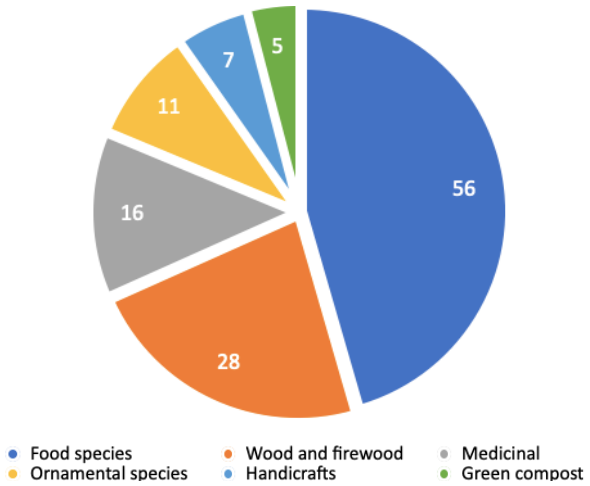


FIGURE 8 – Use categories (%) of the species identified in the backyards in Alta Floresta and Nova Canaã do Norte (MT).

Although the composition of the backyards is quite diverse, there are species that are grown in most of them. Some are present in all backyards (the most common are banana, papaya and citrus). For marketing purposes, the ones that stand out are orange, banana, *cupuaçu*, papaya, and lime (between 60% and 90% of farmers grow and sell them). *Urucum, pequi,* cashew, cassava and maxixe are also important and are marketed in more than 34% of the properties. Annual crops also have considerable importance for agricultural income, such as squash, okra, beans and sweet potato, fruit trees such as pineapple and *graviola*, and condiments, such as sesame and saffron.

These results indicate species that can be potential 'flagship' products in production systems of the communities visited and, perhaps, in other properties of these municipalities.

Of the species identified, 96 were mentioned as already sold by farmers. Most of them have more than one source of marketing (the main ones are farmer's markets and SISCOS - Supportive Marketing System -, a system that receives and markets products from the project for direct sale to the consumer), and some are linked to the PNAE (National School Feeding Program) in both municipalities. These data confirm the importance of backyards in income supplementation in rural community households (Illukpitiya & Yanagida, 2008; Mattsson *et al.*, 2017).

Simonetti *et al.* (2013) state that units with a greater diversity of income sources presented higher incomes in their research. Here, the species cultivated and managed in the backyards also provide farmers with diversity in the channels for transporting and marketing the products of their properties.

3.3. Ecological and environmental benefits from the use of AFSs in the regional context

Thinking on a regional level, the deployment and management of agroforestry intercrops can also be a tool for the reintegration of trees in production systems, which brings benefits to the landscape where they are based. The presence of tree species in the backyards studied seems to contribute to the return and permanence of the forestry component in both municipalities, both characterized by high rates of deforestation, and they accounted for over half of the species identified in the study area. A total of 109 tree species were identified in this study, and more than 1/3 of these are native species. Some of them have great predominance in the backyards and communities visited, among these those from the Amazon region stand out, such as *cupuaçu* (*Theobroma grandiflorum* (Wild ex Spreng.) K.Schum.), *açaí (Euterpe oleracea* Mart.), Brazil nut (*Bertholletia excels* Bonpl), and *paricá (Schizolobium parahyba* Vell. Blake), as do the species that also occur in the Cerrado, such as *pequi (Caryocar brasiliense* Cambess) and *baru (Dipteryx alata* Vogel), all these species with marketing potential and production chains already established in various regions of the country.

There are also several trees among the exclusive species in the backyards, such as *fedegosão (Senna alata* L. Roxb.), *mutamba (Guazuma ulmifolia* Lam.), *mulungu (Erythrina amazonica* Krukoff), *timburi (Enterolobium contortisiliquum* Vell. Morong), *sumaúma (Ceiba pentandra* L. Gaertn.), *bacaba (Oenocarpus distichus* Mart.) e *umbu (Spondias tuberosa* Arruda), all native species used by farmers as a source of timber, medicinal

plants and food in Alta Floresta. In Nova Canaã do Norte, several trees are timber sources, such as *roxinho (Dialium guianese* Aubl. Sandwict), *cedro rosa (Cedrela odorata* L.) e *periquiteira (Buchenavia sericocarpa* Ducke), and we also found important food species native from the region, such as *piquiá (Caryocar villosum* Aubl. Pers.) and *cacauí (Theobroma speciosum* Willd. ex Spreng.).

The use of these species contributes to sustainability and resilience in degraded landscapes since they provide a permanent coverage of trees and are also an option for the restoration and increase of connectivity in these areas (FAO, 2017). These are fruit trees that also provide timber and firewood in the rural properties studied, which indicates their incorporation into the productive system. This possibility of obtaining timber and non-timber forest products as a supplementary source of income can help to reduce the pressures on natural forests (Oliveira & Carvalhaes, 2016).

These results also contribute to a more thorough assessment of the importance of agroforestry backyards for the conservation of biodiversity in the landscape studied (Rayol *et al.*, 2019).

From the perspective of regional development, these results point to the use of AFSs as production systems inserted in what Marsden (2012) calls the "new paradigm of ecological-economic production", meaning an economic activity that "uses natural resources in a more sustainable and environmentally efficient way" (Marsden, 2012, p. 219). In that sense, they can be listed as activities that can contribute with other functions, such as the conservation of the landscape and biodiversity, and the socio-economic viability of rural areas, giving them a multifunctional agriculture character" (Renting *et al.*, 2009, p. S112).

4. Final considerations

The data on richness, consumption, and marketing of cultivated species denote the importance of backyards for productive and dietary diversification, and income supplementation in the households of the communities studied. The high number of species cultivated in multistrata systems (with emphasis on the presence of trees), in turn, denotes a greater number of options and possibilities for cultivation in the region of the study.

The high diversity and small similarity found between the cultivated areas, combined with the fact that many species were introduced after the deployment, indicate differences in preferences and desires of farmers in cultivating different species in their properties, which may be a reflex of the acceptance of the agroforestry model as a production system option, as an alternative to the simplified systems (pastures, in most cases) present in the study region.

The results found in this study may contribute to the spread of AFSs and agroforestry backyards as productive and restoration/conservation systems in the Amazon region of Mato Grosso and, perhaps, to the future expansion of these spaces over the landscape, into areas where this is not a traditional system of production, even on properties of family agriculture.

It is possible to consider backyards biodiverse spaces that reflect the choices of their keepers and diversify their production, favor native species, and contribute to the development and conservation of agrobiodiversity, in addition to meeting the immediate needs of family farmers in the communities, and which may be implemented as new production systems in Portal da Amazônia, contributing to the local and regional development.

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References

Abebe, T.; Wiersum, K. F.; Bongers, F. Spatial and temporal variation in crop diversity in agroforestry homegardens of southern Ethiopia. *Agroforestry Systems*, 78, 309-322, 2010. doi: 10.1007/s10457-009-9246-6

Alcudia-Aguilar, A.; Wal, H. van der; Suárez-Sánchez, J.; Martinez-Zurimendi, P.; Castillo-Uzcanga, M. M. Home garden agrobiodiversity in cultural landscapes in the tropical lowlands of Tabasco, México. *Agroforestry Systems*, 92, 1329-1339, 2018. doi: 10.1007/s10457-017-0078-5

Almeida, L. S. de; Gama, J. R. V. Quintais agroflorestais: estrutura, composição florística e aspectos socioambientais em área de assentamento rural na Amazônia brasileira. *Ciência Florestal*, 24(4), 1041-1053, 2014. doi: 10.1590/1980-509820142404023

Altieri, M. A.; Nicholls, C. I.; Henao, A.; Lana, M. A. Agroecology and the design of climate change-resilient farming systems**.** *Agronomy for Sustainable Development*, 35, 869-890, 2015. doi: 10.1007/s13593-015-0285-2

Amaral, C. N. do; Guarim Neto, G. Os quintais como espaços de conservação e cultivo de alimentos: um estudo na cidade de Rosário Oeste (Mato Grosso, Brasil). *Boletim do Museu Paraense Emílio Goeldi Ciências Humanas*, 3(3), 329-341, 2008. doi: 10.1590/S1981-81222008000300004

Andrade, J. P. S. de. *A implantação do pagamento por serviços ecossistêmicos no território Portal da Amazônia*: uma análise econômico ecológica. Campinas, Dissertação (Mestrado em Desenvolvimento Econômico) – UNICAMP, 2007.

Bonini, I.; Marimon-Junior, B. H.; Matricard, E.; Phillips, O. L.; Petter, F.; Oliveira, B.; Marimon, B. S. Collapse of ecosystem carbon stocks due to forest conversion soybean plantations at the Amazon-Cerrado transition. *Forest Ecology and Management*, 414, 64-73, 2018. doi: 10.1016/j.foreco.2018.01.038

Brazil Flora Group. *Brazilian flora 2020 project*, 2021. Disponível em: <http://ipt.jbrj.gov.br/jbrj/resource?r=lista_especies_flora_brasil&request_locale=pt>. Acesso em: out. 2021.

Carniello, M. A.; Silva, R. dos S.; Cruz, M. A. B. da; Guarim Neto, G. Quintais urbanos de Mirassol D'Oeste-MT, Brasil: uma abordagem etnobotânica. *Acta Amazonica*, 40(3), 451-470, 2010. doi: 10.1590/S0044-59672010000300005

CEAAF – Conselho executivo de ações da agricultura familiar. *Plano territorial de desenvolvimento rural sustentável*: território da cidadania Portal da Amazônia, 2010. Disponível em: <http://sit.mda.gov.br/download/ptdrs/ptdrs_qua_territorio074.pdf>. Acesso em: jun. 2017.

Chirwa, P. W.; Mala, W. Trees in the landscape: towards the promotion and development of traditional and farm forest management in tropical and subtropical regions. *Agroforestry Systems*, 90(4), 555-561, 2016. doi: 10.1007/s10457-016-9987-y

Coelho, M. F. B.; Leal, C. C. P.; Oliveira, F. B.; Nogueira, N. W.; Freitas, R. M. O. Levantamento etnobotânico das espécies vegetais em quintais de bairro na cidade de Mossoró, Rio Grande do Norte. *Revista Verde de Agroecologia e Desenvolvimento Sustentável*, 11(4), 154-162, 2016. doi: 10.18378/rvads.v11i4.3953

Cook, E. M.; Hall, S. J.; Larson, K. L. Residential landsca-

pes as social-ecological systems a synthesis of multi-scalar interactions between people and their home environment. *Urban Ecosystems,* 15, 19-52, 2012. doi: 10.1007/s11252-011-0197-0

Deponti, C. M. As "agruras" da gestão da propriedade rural pela agricultura familiar. *Redes - Revista do Desenvolvimento Regional* (Santa Cruz do Sul), 19, 9-24, 2014. doi: 10.17058/redes.v19i2014.5150

Eichemberg, M. T.; Amorozo, M. C. de M. Contributions of the old urban homegardens for food production and consumption in Rio Claro, Southeastern Brazil. *Boletim do Museu Paraense Emílio Goeldi Ciências Humanas*, 8(3), 745-755, 2013. doi: 10.1590/S1981-81222013000300015

FAO – Organização das Nações Unidas para Alimentação e Agricultura. *Agroforestry for landscape restoration*: exploring the potential of agroforestry to enhance the sustainability and resilience of degraded landscapes, 2017. Disponível em: <http://www.fao.org/3/b-i7374e.pdf>. Acesso em: out. 2021.

Ferreira Júnior, E. V.; Soares, T. S.; Costa, M. F. F.da; Silva, V. S. M. Composição, diversidade e similaridade florística de uma floresta tropical semidecídua submontana em Marcelândia – MT. *Acta Amazonica,* 38(4), 673-680, 2008. doi: 10.1590/S0044-59672008000400010

Flores, J. C. G.; Cedillo, J. G. G.; Plata, M. A. B.; Santana, M. R. A. Sociocultural and environmental benefits from family orchards in the Central Highlands of Mexico. *Bois et Forêts des Tropiques*, 329(3), 29-42, 2016. doi: 10.17632/sxzvv59pgg.1

Galhena, D. H.; Freed, R.; Maredia, K. M. Home-gardens: a promising approach to enhance household food security and wellbeing. *Agriculture & Food Security*, 2, 8, 2013. doi: 10.1186/2048-7010-2-8

Garcia, B. N. R.; Vieira, T. A.; Oliveira, F. de A. Tree and shrub diversity in agroforestry homegardens in rural community in eastern amazon. *Floresta*, 47(4), 543-552, 2017. doi: 10.5380/rf.v47i4.48196

Gervázio, W. *Agrobiodiversidade e qualidade do solo em quintais agroflorestais urbanos na cidade de Alta Floresta – MT.* Alta Floresta, Dissertação (Mestrado em Biodiversidade e Agroecossistemas Amazônicos) – UNEMAT, 2015.

Gliessman, S. R. *Agroecologia*: processos ecológicos em agricultura sustentável. Porto Alegre: Editora UFGRS, 2009.

Gonçalves, J. P.; Lucas, F. C. A. Agrobiodiversidade e etnoconhecimento em quintais de Abaetetuba, Pará, Brasil. *Revista Brasileira de Biociências***,** 15(3), 119-134, 2017. Disponível em: http://www.ufrgs.br/seerbio/ojs/index.php/rbb/article/view/3756

Henkel, K.; Amaral, I. G. Análise agrossocial da percepção de agricultores familiares sobre sistemas agroflorestais no nordeste do estado do Pará, Brasil. *Boletim do Museu Paraense Emílio Goeldi*, 3(3), 311-327, 2008. doi: 10.1590/S1981-81222008000300003

IBGE – Instituto Brasileiro de Geografia e Estatística. *Bases cartográficas contínuas – Brasil*, 2016. Disponível em: <https://www.ibge.gov.br/geociencias/cartas-e-mapas/bases-cartograficas-continuas/15759-brasil.html?=&t=o-que-e>. Acesso em: out. 2019.

IBGE – Instituto Brasileiro de Geografia e Estatística. *Cidades@*, 2017. Disponível em: <https://cidades.ibge.gov.br>. Acesso em: jun. 2017.

Illukpitiya, P.; Yanagida, J. F. Role of income diversification in protecting natural forests: evidence from rural households in forest margins of Sri Lanka. *Agroforestry Systems*, 74, 51-62, 2008. doi: 10.1007/s10457-008-9153-2

INPE – Instituto Nacional de Pesquisas Espaciais. *Monitoramento do desmatamento da Floresta Amazônica brasileira por satélite*, 2020. Disponível em: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>. Acesso em: out. 2020.

Maciel, R. C. G.; Cavalcante Filho, P. G.; Lima Júnior, F. B.; Souza, E. F. Distribuição de renda na Amazônia: um estudo dos polos agroflorestais em Rio Branco – AC. *Desenvolvimento Regional em Debate*, 8(2), 108-142, 2018. doi: 10.24302/drd.v8i2.1416

Marsden, T. Sustainable place-making for sustainability science: the contested case of agri-food and urban–rural relations. *Sustainable Science*, 8, 213-226, 2013. doi: 10.1007/s11625-012-0186-0

Martin, M.; Geiger, K.; Singhakumara, B. M. P.; Ashton, M. S. Quantitatively characterizing the floristics and structure of

a traditional homegarden in a village landscape, Sri Lanka. *Agroforestry Systems*, 93, 1439-1454, 2019. doi: 10.1007/s10457-018-0254-2

Mattsson, E.; Ostwald, M.; Nissanka, S. P. What is good about Sri Lankan homegardens with regards to food security? A synthesis of the current scientific knowledge of a muntifunctional land-use system. *Agroforestry Systems*, 92, 1469-1484, 2018. doi: 10.1007/s10457-017-0093-6

Neves, P. D. M. Sistemas agroflorestais como fomento para a segurança alimentar e nutricional. *Revista Verde de Agroecologia e Desenvolvimento Sustentável*, 8(5), 199-207, 2014. Disponível em: https://www.gvaa.com.br/revista/index.php/RVADS/article/view/2157

Noronha, G. S.; Falcón, M. L. de O. A disputa entre modelos para o campo: apontamentos sobre a questão agrária no Brasil em busca de um novo paradigma. *Saúde e Debate*, 42(3), 183-198, 2018. doi: 10.1590/0103-11042018S314

Okonoski, T. R. H.; Nabosny, A. Agroecologia e dinâmica socioespacial local: uma alternativa para agricultores familiares de São Mateus do Sul – PR. *Terra Plural*, 3(1), 67-87, 2009. doi: 10.5212/TerraPlural.v.32i1.067087

Olival, A. de A. A resiliência em assentamentos rurais: uma experiência na região norte de Mato Grosso. *Sustentabilidade em Debate*, 7(2), 90-113, 2016. doi: 10.18472/SustDeb.v7n2.2016.15320

Olival, A. A.; Buschbacher, R.; Oliveira, R. E.; Rodrigues, C. H.; Bartels, W. L.; Olival, A. A. S.; Arantes, V. T.; Farias, R. A.; Scaglia, S. Resiliência da agricultura familiar na Amazônia: co-construção de um programa de pesquisa-ação multiinstitucional no Brasil. *In*: *II Encontro Lusófono em Economia, Sociologia, Ambiente e Desenvolvimento Rural.* Évora, 7-9 de set., 2016.

Oliveira Junior, C. J. F.; Cabreira, P. P. Sistemas agroflorestais: potencial econômico da biodiversidade vegetal a partir do conhecimento tradicional ou local. *Revista Verde de Agroecologia e Desenvolvimento Sustentável,* 7(1), 212-224, 2012. Disponível em: https://www.gvaa.com.br/revista/index.php/RVADS/article/view/1153

Oliveira Junior, C. J. F. de; Voigtel, S. D. S.; Nicolau, S. A.; Aragaki, S. Sociobiodiversidade e agricultura familiar em Joanópolis, SP, Brasil: potencial econômico da flora local. *Hoehnea*, 45(1), 40-54, 2018. doi: 10.1590/2236-8906-78/2017

Oliveira, R. E. de; Carvalhaes, M. A. Agroforestry as a tool for restoration in Atlantic Forest: can we find multipurpose species? *Oecologia Australis*, 20(4), 425-435, 2016. doi: 10.4257/oeco.2016.2004.03

Oliveira, R. E. de; Sais, A.C.; Olival, A. de A; José, P.B.; Souza, V. da C. de; Soares, D.R.; Paula, R. P. de. As agroflorestas como estratégia de resiliência no Portal da Amazônia. *In*: Olival, A. de A.; Rodrigues, C. H.; Oliveira, R. E. de; Buschbacher, R.; Bartels, W. L. (Orgs.). *Na trilha das mudanças*: ciência e resiliência da agricultura familiar na Amazônia norte mato-grossense. Caceres: Editora Unemat, p. 105-138, 2021.

Paulo, C. M. de; Cintra, L. M.; Cunha, L. M. V.; Otta, D. V.; Engelmann, E. Expansão da fronteira agropecuária e desmatamento na região de Alta Floresta/MT: alternativas para o desenvolvimento sustentável. *Revista Gestão & Políticas Públicas*, 5(1), 108-130, 2015. doi: 10.11606/issn.2237-1095.v5i1p108-130

Pereira, S. C. B.; Jardim, I. N.; Freitas, A. D. D. de; Paraense, V. de C. Levantamento etnobotânico de quintais agroflorestais em agrovila no Município de Altamira, Pará. *Revista Verde de Agroecologia e Desenvolvimento Sustentável*, 13(2), 200-207, 2018. doi: 10.18378/rvads.v13i2.5292

Quaresma, A. P.; Almeida, R. H. C.; Oliveira, C. M.; Kato, O. R. Composição florística e faunística de quintais agroflorestais da agricultura familiar no nordeste paraense. *Revista Verde de Agroecologia e Desenvolvimento Sustentável*, 10(5), 76-84, 2015. doi: 10.18378/rvads.v10i5.3706

Rayol, B. P.; Vale, I. do; Miranda, I. S. Tree and palm diversity in homegardens in the Central Amazon. *Agroforestry Systems*, 93, 515-529, 2019. doi: 10.1007/s10457-017-0144-z

Renting, H.; Rossing, W. A. H.; Groot, J. C. J.; Ploeg, J. D. van der; Laurent, C.; Perraud, D.; Stobbelaar, D. J.; Ittersum, M. K. van. Exploring multifunctional agriculture: a review of conceptual approaches and prospects for an integrative transitional framework. *Journal of Environmental Management*, 90, S112-S123, 2009. doi: 10.1016/j.jenvman.2008.11.014

Roboredo, D.; Bergamasco, S. M. P. P. Recuperação so-

cioambiental de agroecossistemas: questões e desafios para sua viabilização. *Retratos de Assentamentos,* 16(1), 151-179, 2013. doi: 10.25059/2527-2594/retratosdeassentamentos/2013.v16i1.133

Schmink, M.; Wood, C. H. *Contested Frontiers in Amazonia*. New York: Columbia University Press, 1992.

Schneider, S.; Niederle, P. A. Resistance strategies and diversification of rural livelihoods: the construction of autonomy among brazilian family farmers. *The Journal of Peasant Studies*, 37(2), 379-405, 2010. doi: 10.1080/03066151003595168

Sêdami, A. B.; Naésse, A. V.; Pascal, G.; Firmin, A. D. Importance of home gardens in rural zone of the municipality of Abomey-Calavi in South of Republic of Benin. *Sustainable Agriculture Research***,** 6(4), 150-160, 2017. doi: 10.5539/sar.v6n4p150

Serrano-Ysunza, A. A.; Wal, H. van der; Gallardo-Cruz, J. A.; Ramos-Muñoz, D. E.; Vaca, R. A. A 6-year longitudinal study on agrobiodiversity change in homegardens in Tabasco, México. *Agroforestry Systems*, 92, 1485-1494, 2018. doi: 10.1007/s10457-017-0094-5

Simioni, F. J.; Hoff, D. N.; Silva, C da. Diversificação e atividades não agrícolas como alternativas de renda para agricultura familiar: um estudo de caso no município de Painel/SC. *Revista Brasileira de Gestão e Desenvolvimento Regional*, 12(2), 185-207, 2016. doi: 10.54399/rbgdr.v12i2.2318

Simonetti, D.; Perondi, M. A.; Kiyota, N.; Villwock, A. P. S. Diversificação da renda e agregação de valor na agricultura familiar: lições a partir de uma comunidade rural. *Revista Extensão Rural*, 20(2), 132-144, 2013. Disponível em: https://periodicos.ufsm.br/extensaorural/article/view/7168

Siviero, A.; Delunardo, T. A.; Haverroth, M.; Oliveira, L. C. de; Mendonça, A. M. S. Cultivo de espécies alimentares em quintais urbanos de Rio Branco, Acre, Brasil. *Acta Botanica Brasilica*, 25(3), 549-556, 2011.

Souza, V. da C. de. *Caracterização de agroecossistemas utilizados por agricultores familiares em comunidades rurais no portal da Amazônia – Mato Grosso:* agrobiodiversidade, alimentação e geração de renda. Araras, Dissertação (Mestrado em Agroecologia e Desenvolvimento Rural) – UFSCar, 2019.

The Plant List. *The plant list*, 2010. Disponível em: <http://www.theplantlist.org/>. Acesso em: out. 2021.

UNESCO – Organização das Nações Unidas para a Educação, Ciência e Cultura. *Orientações técnicas para aplicação da convenção do património mundial*, 2017. Disponível em: <https://whc.unesco.org/document/169402>. Acesso em: out. 2021.

Vasconcelos A.; Bernasconi, P.; Guidotti, V.; Silgueiro, V.; Valdiones, A.; Carvalho, T.; Bellfield, H.; Pinto, F. L. G. Illegal deforestation and brazilian soy exports: the case of Mato Grosso. *Trase*, 4, 2020. Disponível em: https://www.icv.org.br/website/wp-content/uploads/2020/06/traseissuebrief4-en.pdf

Vielmo, O.; Drumm, E. C.; Deponti, C. M. A gestão da agricultura familiar: pluriatividade, diversificação da produção e agricultura orgânica – um estudo de caso da região da Campanha. *Colóquio - Revista do Desenvolvimento Regional*, 14(2), 49-68, 2017. doi: 10.26767/coloquio.v14i2.717

Weihs, M.; Sayago, D.; Tourrand, J. F. Dinâmica da fronteira agrícola do Mato Grosso e implicações para a saúde. *Estudos Avançados*, 31(89), 323-338, 2017. doi: 10.1590/s0103-40142017.31890024