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Socioeconomics of Urban Agriculture in Curuçambá Neighborhood, Metropolitan Region of Belém, Brazilian Amazon

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Abstract

This study aims to characterize the agricultural production systems under urban and peri-urban agriculture (UPA) in the Curuçambá neighborhood; identify the main techniques and technologies adopted, cultivations and creations conducted, and the activity relationship within the Metropolitan Region of Belém (RMB); and estimate the production contribution to family consumption complementarily and exploratorily. Data were obtained through interviews conducted among 63 residents in the neighborhood (representing 52.50% of the universe) by monitoring the food consumption of six producers' families for two weeks and georeferencing images from Google Satellite. Farmers were mainly from the northeast of Pará (57.14%) and other Brazilian states such as Maranhão (9.52%), Ceará (9.52%), and Paraíba (1.59%). Clearly, urban agriculture in the region was established during the migration of rural areas to Amazonian cities. Generally, most farmers had reached elementary school II (69.84%) and had an average monthly income of one to two minimum wages (50.79%). Agricultural production was promoted by approximately 111 residences in the neighborhood and was based on horticulture and small livestock keeping. Additionally, the items analyzed were allegedly produced in six production systems: common beds (71.43%), suspended beds (12.70%), fruticulture (6.35%), agroforestry yards (3.17%), hydroponics (4.76%), and aquaponics (1.59%), and were directed to supply the RMB markets. On average, 30.89% of farmers' income covered family consumption; we estimated the opportunity cost of consumption for the five main products cultivated in the neighborhood (jambu, lettuce, coriander, chicory, and cariru) as R$ 79.88 monthly, accounting for 8.37% of the current minimum wage at that time.

Keywords: urban agriculture, family farming, production systems, food security, Amazonian cities

1. Introduction

The accelerated urbanization process has always entailed problems such as increased poverty, environmental pollution, food insecurity, malnutrition, and increased unemployment (Orsini et al., 2013). This phenomenon has brought about adversities in Brazil and worldwide. However, no difference was noted in the municipality of Ananindeua, the state of Pará.

The formation of agricultural areas in the urban zone of Ananindeua reflects the disordered and accelerated urbanization process that occurred almost throughout the Brazilian Amazon, stimulated mainly by colonization policies managed and implemented by military governments between the 1970s and 1980s during the implementation of mining projects, which boosted an increasing migration movement to the region, aimed at settlement and integration of the region into the national territory (Madaleno, 2002).

During this period, people from rural areas, mainly from the countryside of the state of Pará and northeast Brazil, migrated to Ananindeua. These people were skilled in agricultural activities and did not meet the cities' labor requirements, causing a "populational swelling" and their subsequent marginalization. Thus, in an attempt to reverse this situation, people who previously performed rural activities but lived in urban areas began searching for ways to solve these issues. As one of the solutions, agriculture in the cities was made a subsistence alternative and economical reproduction.

Urban and peri-urban agriculture (UPA) is related to the primary sector developed in the urban environment (Silva and Sablayrolles, 2014). According to Madaleno (2002) and Santandreu and Lovo (2007), it refers to the group of laborers developed and instituted from the production and service provision for agricultural products such as foodstuffs of plant and animal origins and species useful for people and oriented to self-consumption, exchanges, donation, and commercialization, (re)using local resources and inputs efficiently and sustainably, such as solid residues and residual water, generated by activities of the urban spaces or town peripheries.

Originally, UPA was a terminology used in academia (Mougeot, 2005) to designate the aspects of agriculture and livestock production inside and around the urban perimeter. Nowadays, the systems of communication and actions of public and private initiatives are gradually considering the issue more, involving urban communities in the concept and enabling its visibility regarding social aspects, which involve families in job creation and income generation, when it comes to their capacity to provide healthier food to consumers.

This type of agriculture allows urban conflicts to be mitigated, especially the possibility of income generation and food security. Agricultural and livestock production in cities reduces the cost of feeding urban farmers, considering that urban families spend between 60% and 80% of their regular income on food (Mougeot, 2005; Zeeuw et al., 2011; FAO, 2012). Additionally, families who produce more than they need for their own consumption might sell their surplus, complementing family income and contributing to food supply in urban markets.

Although much is already understood about its nature, it appears that these studies require revision, especially to understand the relationships of this segment with urban societies and the formulation of specific public policies that meet the demands of the agricultural sector in this new context of production and marketing.

In the Amazon, specifically in the state of Pará, research and initiatives to support UPA are at an early stage. In most municipalities, especially those that make up metropolitan areas, public authorities of UPA do not recognize or legitimize it as an individualized productive activity; it is rather generally treated as a purely rural one (Santos and Silva, 2007).

In Ananindeua's case, urban agriculture develops, particularly, in the peri-urban areas of the municipality (Honda et al., 2016). This phenomenon in the Curuçambá neighborhood, the locus of this study, is demonstrated to be consolidated by family farming enterprises that meet the demands of the market in the metropolitan region of Belém (RMB).

Therefore, this study aims to characterize the agricultural production systems practiced by peri-urban farmers in the Curuçambá neighborhood, identifying the techniques and technologies adopted, main husbandry conducted, and relationship between this activity and the RMB context. Specifically, we attempt to estimate the contribution of the production of these farmers to their own family consumption in a complementary and exploratory way.

2. Method

2.1 Study Area

According to the IBGE (2019), Ananindeua is a municipality that belongs to the RMB, with an estimated population of 530,598 inhabitants; it has the second-highest housing concentration among the 144 municipalities in Pará, after Belém, the state's capital. In 2017, the municipal gross domestic product (GDP) was R$ 6,979,135.03, corresponding to 4.5% of Pará's GDP (R$ 155,195 billion). The Human Development Index was classified as high and measured at 0.718 (AtlasBR, 2017).

This research was conducted in the Curuçambá neighborhood (municipality of Ananindeua), a region formed from the housing policy established and implemented by the Housing Company of the State of Pará (COHAB-PA) in the neighborhoods of *Cidade Nova* during the 1970s and 1980s. At that time, the settlement plan for the most central regions stimulated both intra-urban migration and the flow of people from locations outside Ananindeua to the city's peripheral areas. As it is a peripheral area of the municipality with large spaces available, the Curuçambá neighborhood made it possible for small agricultural enterprises to be created, consolidating an increase in activity around the RMB over time.

2.2 Sample Group

Initially, owing to the inaccuracy of documents describing the size of the population performing the activity in the neighborhood, the Declaration of Aptitude to National Program for the Strengthening of Family Farming (PRONAF (DAP)) was used as a statistical measurement – provided by leaders of the *Cooperativa dos Produtores da Gleba Guajará* (COPG – “Gleba Guajará Producers Cooperative”) – as well as the quantification of agricultural areas by Google Satellite images from the software QGIS Las Palmas 2.16.24, similar to the geospatial analysis performed by Mackay (2018).

The number of COPG members is noted in the DAP document. A total of 315 members were found to be living in the municipalities of Ananindeua, Curuçá, Santa Bárbara do Pará, Santo Antônio do Tauá, Acará, and Marapanim. Among them, 134 people settled under the National Agrarian Reform Program (PRNA) and 49 *quilombolas* (African Brazilian settlements).

After this initial screening of the DAP list, it was observed that 120 associated individuals were residents of the municipality of Ananindeua. However, the information established in the document included only their cities of residence, excluding the addresses of the associated farmers, hence not ensuring that all of them were residents of Curuçambá. Additionally, the sampling clearly showed that in the main agricultural areas of the neighborhood, producers in general were not members of the cooperative.

Through personal communication with COPG managers, it was noted that some of the cooperative members were living in other neighborhoods in the municipality, such as PAAR, Icuí Guajará, Maguari, and the Ananindeua’s islands region. Hence, they did not meet the inclusion criteria of the research participants because they did not live in the study area.

Given the limitations of the listing, images from Google Satellite were analyzed to assess the number of households with urban agriculture in the locality as an alternative to estimate the number of agricultural enterprises in the neighborhood. Some field visits required correction to improve the accuracy of the information obtained by geoprocessing. Through this analysis, it was possible to count 111 agricultural units.

By aggregating information through field surveys, official documents, and the geoprocessing of satellite images and considering that each production unit had at least one agricultural business manager, it was estimated that 120 urban farmers would make up the research sample. Sampling was initially conducted by inviting participants as indicated by directors of COPG. Random approach visits to residential units in the neighborhood were subsequently expanded.

To facilitate access to possible participants, the “snowball” technique was also used, allowing the interviewees to indicate individuals who also worked in the field in areas not previously selected. Of the 120 farmers present in the universe, 63 urban farmers were selected, of whom 23 were COPG members and 40 were uncooperative urban farmers, accounting for 52.50% of the identified sample. Several interviews were conducted with key actors in the Curuçambá neighborhood (the oldest residents, community leaders, and traders) to gather information about the dynamics of urbanization and land use in the study area.

2.3 Data Collection Instrument

For the field data survey, a semi-structured questionnaire was administered through interviews with agricultural business managers in the locality. These interviews aimed at collecting information regarding the agricultural production, such as types of products grown, average quantity produced for each item, techniques and technologies used, and relative consumption of items produced in the production unit, in addition to other pieces of information describing the socioeconomic profile of respondents and conjuncture of production. The questionnaire obtained results similar to the observations of Pacheco et al. (2018), Araújo et al. (2017), Silva and Sablayrolles (2014), Santos and Silva (2007), and Madaleno (2002), enabling a broad comparison with the results of other studies conducted in the state of Pará.

The questionnaires were filled out while ensuring the anonymity of the participants. The informants knew that they were participating in a data survey for scientific analysis; none of them expressed discomfort or asked to have their data excluded from the study. The research was duly registered with the National Research Ethics Commission (CONEP) through *Plataforma Brasil*.

2.4 Data Analyses

Microsoft Office Excel 2016 was used to tabulate and process the data obtained in this study. The methods of analysis were based on descriptive statistical models. Specific analyses of economic science were conducted to assess the relationship between the “average monthly family income” and “number of residents of each production unit” to further establish a per capita family income parameter.

The *per capita* income values of urban farmers in the neighborhood were compared and analyzed with the value of the indicator for the state of Pará present in the National Survey by Continuous Household Sample (PNAD) from IBGE (2018). Following the last result presented in 2018, the value for September 2019 was deflated through the General Price Index – Internal Availability (IGP-DI).

Regarding estimating the self-consumption of production in family food, information was collected from the questionnaire administered to the 63 interviewees. However, because of the lack of precise methods that would make this analysis possible and highly reliable, the consumption of six families was monitored in a complementary way over a period of two weeks.

To establish an opportunity cost ratio, information was taken as a reference, such as the monthly consumption of vegetables by families that were observed for two weeks, price of the product at the retail level in the main RMB markets, and relative average quantity of products taken monthly from the field by the sample farmers. Additionally, the data on the total volume of products from the agricultural zone was sufficient to estimate the proportion of the quantity consumed by the quantity produced. The study’s qualitative data were analyzed from the field observation speeches of the interviewees, which were further compared with the arguments defended in the specialized literature.

3. Results and discussion

3.1 History of Urban Agriculture in the Curuçambá Neighborhood

Since the transition to the 1980s, the Curuçambá neighborhood has been considered a pole of frequent migration (Honda et al., 2016). During this period, there was intense migration and spontaneous occupation in the peri-urban areas of the municipality of Ananindeua (PA), which was also intensified by the development of the housing plan of the Housing Company of the State of Pará (COHAB-PA) implemented in the current area of the *Cidade Nova* neighborhood. During this process, the population specializing in agriculture grew, and small "ruralized" spaces contrasted with the urban environment appeared. In the same decade, COHAB-PA's policy relocated 16 farmers who practiced agriculture in the neighborhoods covered by the plan.

These producers, aiming to gain visibility in the urban scenario, and public policies, aimed at family farming, founded the *Caixa Agricola dos Produtores Rurais do Guajará* in 1980, which executed activities in the interest of urban farmers in the neighborhood for eight years. However, owing to statutory limitations and isolated actions, the ability to get federal, state, and municipal government benefits and programs was restricted.

Therefore, according to Honda et al. (2016) and Pereira et al. (2019), on August 15, 1988, the legal condition of *Caixa Agrícola* was revised to the associative model, changing its name to "*Associação dos Produtores e Hortifrutigranjeiros da Gleba Guajará*" (APHA/PA). In 2012, aiming to incorporate greater possibilities to act in the face of the proposals developed by the government, APHA joined the cooperative system, becoming the "*Cooperativa dos Produtores da Gleba Guajará*," which is currently characterized as an organization that operates within the two systems, both as an association and a cooperative.

Currently, Curuçambá is in a neighborhood with residential areas and many family enterprises in agriculture and local markets (like the "*feirinha*"). It is an area of contrast where few individuals are apparently financially "fortunate," while many live in precarious health, education, and public safety conditions.

3.2 Socioeconomic Profile of Urban Farmers in the Curuçambá Neighborhood

The population of the Curuçambá neighborhood that works in agriculture is generally composed of migrants from municipalities in the Northeast of Pará (57.14%), such as Acará (3.17%), Augusto Corrêa (6.35%), Bragança (9.52%), Bujarú (3.17%), Curuçá (3.17%), Irituia (4.76%), and Ourém (4.76%). Moreover, 20.63% come from municipalities in the states of Maranhão (9.52%), Ceará (9.52%), and Paraíba (1.59%).

The other 22.22% are from the municipalities of Ananindeua, Belém, Benevides, Castanhal, and Santa Isabel (all of them belong to the metropolitan region of Belém), of which 11.11% were born in the municipality of Ananindeua. This native portion of the municipality is mainly composed of young farmers, mostly children of people who migrated to the region and worked in the activity, establishing a continuity of the practice transmitted among generations.

The interviewees were aged between 21 and 81 years, with an age range of 60 years. The average age was 49.25 years, with a relative frequency of 65.08% of cases between 35 and 60 years, forming a group predominantly of middle-aged adults, as shown in Table 1.

Table 1. Age range of urban farmers who manage businesses in the Curuçambá neighborhood, 2019

Age range	f_{ri} (%)	Mean	Standard deviation
Young adults (18 to 35 years old)	14.29	29.67	4.30
Middle-age adults (35 to 60 years old)	65.08	46.77	5.67
Elderly (above 60 years old)	20.63	67.47	6.39
Total	100.00	49.25	13.08

Source: Research data.

It is possible to analyze the presence of a few young adults (14.29%) in the management of urban agriculture businesses. Although the results are similar to those obtained in the studies by Araújo et al. (2017), it is noted that the producers of Curuçambá are relatively older than those found in other studies analyzed in the review.

Furthermore, it was found that 74.60% of the producers were male and 25.40% were female. Different data from Madaleno (2002), Araújo et al. (2017), and Pacheco et al. (2018) in studies conducted at the RMB indicated that agricultural practices were predominantly performed by women. The explanation for this difference is that in those surveys, the interviewees' main job activity was not agriculture; they would rather mold themselves into a practice focused on subsistence and social integration within the urban household itself. In contrast, the reality in the Curuçambá neighborhood shows an agricultural practice that focuses on meeting market demand, which requires complete dedication and tremendous physical effort.

The urban farmers had mainly reached elementary school II from 5th to 9th grade (69.84%), also considering the illiterate group (6.35%). Of the participants, 25.4% had studied up to high school, and only 4.76% had a higher education level (Table 2). In many studies on family farming and urban agriculture in developing countries, it is common for the education level to be between elementary I and high school (Pacheco et al., 2018).

Table 2. Education level of urban farmers who managed businesses in the Curuçambá neighborhood, 2019

Education level	f_{ri} (%)
Illiterate	6.35
Elementary School I (1st to 4th)	31.75
Elementary School II (5th to 9th)	31.75
Incomplete High School	14.29
Complete High School	11.11
Higher Education	3.17
PHD	1.59
Total	100.00

Source: Research data.

Regarding the main occupation, 88.89% had agriculture as their primary work activity, and 11.11% had agricultural practice as a secondary activity. It is important to note that in Curuçambá's entire context, the production aims to meet market demand even in cases where agriculture is considered a secondary occupation.

Among the 11.11% who have a secondary activity in agriculture, it was observed that their main work activities were related to informal work (e.g., bricklaying and street market vending) and wage earnings (store inspectors and security guards), and 1.59% worked in higher education teaching. In Araújo et al. (2017) and Pacheco et al. (2018), most interviewees engaged in other job activities as a strategy to obtain extra income.

Intrinsic to this issue, it was found that similar to Araújo et al. (2017), the average monthly family income in 50.79% of the sample was between 1 to 2 minimum wages. Additionally, 25.40% of the interviewees survived with an income of up to one minimum wage, as shown in Figure 1.

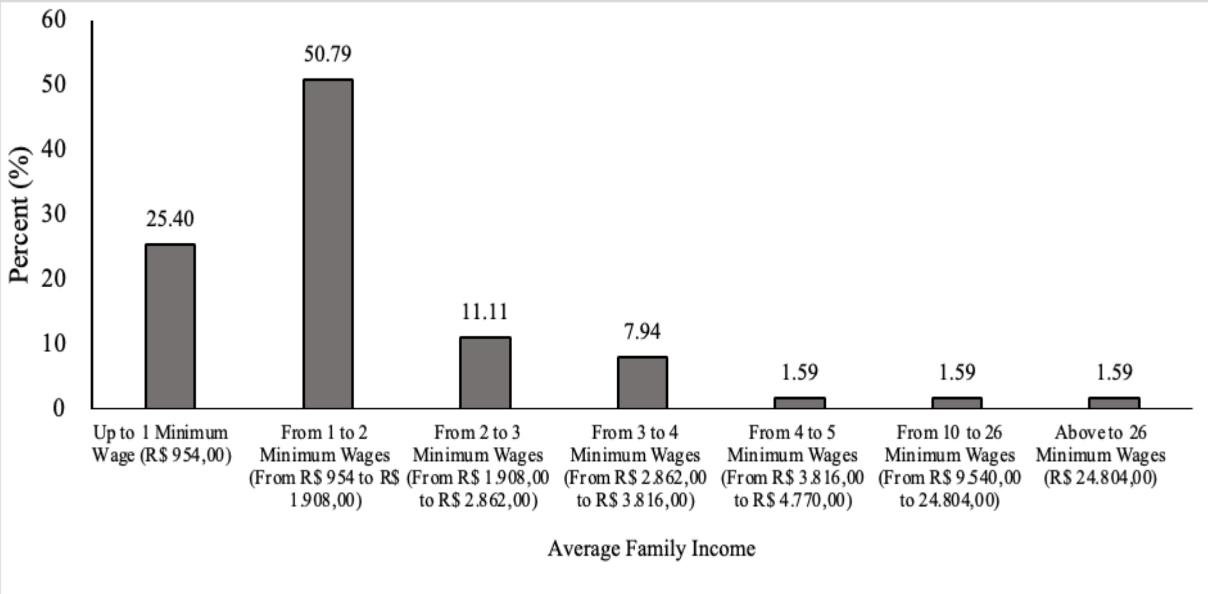

Figure 1. Average monthly family income of urban farmers in the Curuçambá neighborhood, 2019

Source: Research data.

According to (Zeeuw et al., 2011), most urban and peri-urban farmers in developing countries belong to the poorest strata of the population. There is also participation from middle-class people and entrepreneurs seeking good investment of their money.

According to the IBGE (2018), the *per capita* income in the state of Pará was R$863.00 per month in 2018. Following the deflation of the amount based on the IGP-DI of September 2019, the adjusted amount was R$ 888.89 monthly. Therefore, based on the data from this research, it was found that 73.02% of urban farmers living in Curuçambá have a *per capita* income below the state's average income.

More than half of the farmers (58.73%) received one or more types of benefits from social programs, of which 33.33% are beneficiaries of "*Bolsa Família*," a program promoted by the federal government. Retirees account for 9.52%, where 4.76% receive some type of payment. The other 11.11% are beneficiaries of programs, such as assistance benefits for people with disabilities, accident assistance, age benefit, and invalid assistance.

The benefits received from social programs such as *Bolsa Família* and retirement were similar to those found by Pacheco et al. [13] for an analysis conducted in urban agriculture in the Montese neighborhood (municipality of Belém). Despite not being covered by public policies aimed at urban agriculture, it is observed that the producers of Curuçambá have, indirectly, some insertion in social protection policies that mitigate the precarious living conditions found in the peri-urban area of Ananindeua.

3.3 Agriculture in the Curuçambá Neighborhood

From the analysis made by the geoprocessing of images from the Google Satellite, 111 agricultural units were noted throughout the neighborhood. These are mainly concentrated in the central and western regions of Curuçambá and are practically inexpressive in other areas of the neighborhood, as shown in Figure 2.

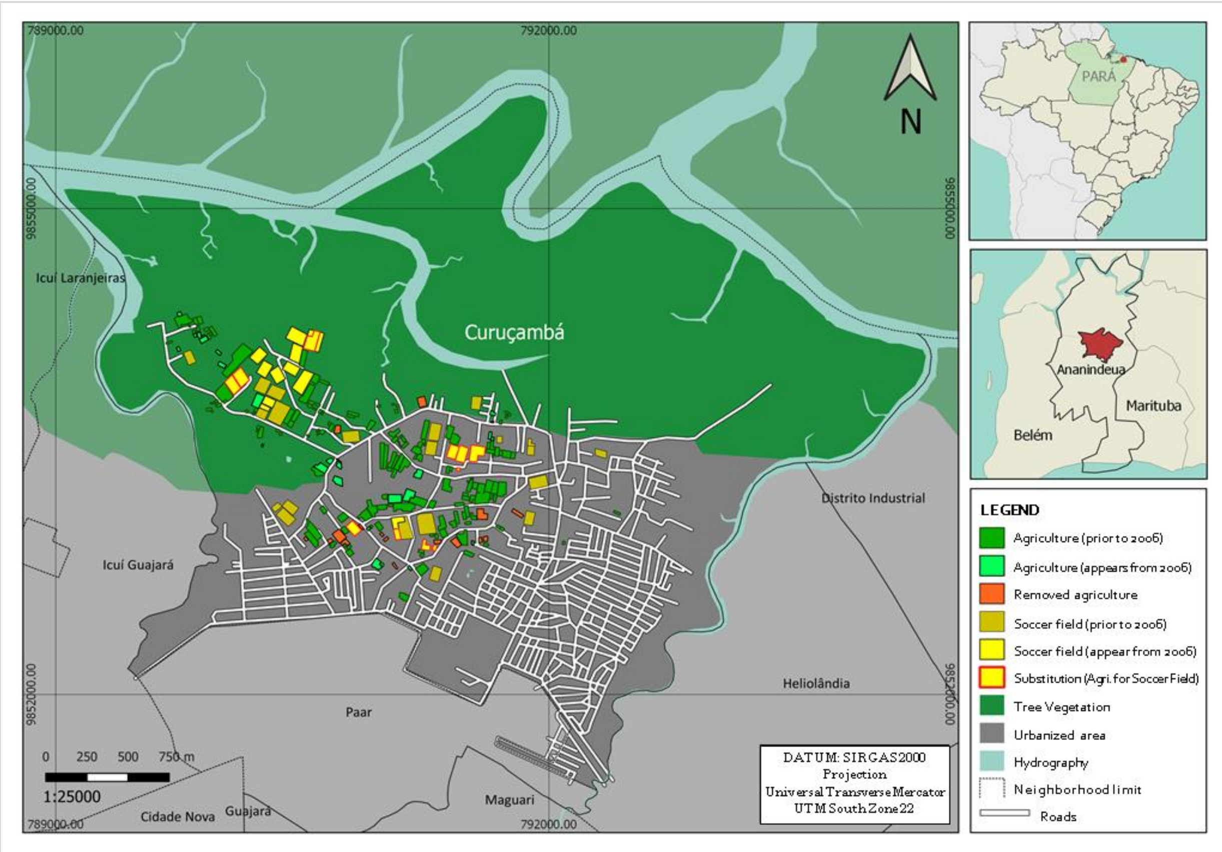

Figure 2. Spatial behavior of urban agriculture enterprises in the Curuçambá (PA) neighborhood between 2006 and 2019

Source: Research data.

During the field survey, it was found that some activities expanded in the neighborhood and occupied areas that were previously intended for agricultural practices. In this sense, the construction of soccer fields for rent has expanded throughout Curuçambá over the years, showing a substitution of the use of agricultural areas for this type of enterprise.

Such substitution occurs owing to the favorable economic return that sports practice has and the lower labor requirement compared with agriculture. The rent of the field per soccer match (90 minutes) varies between R$ 100.00 on weekdays and may reach up to R$ 500.00 on weekends. This sports space rental market emerged to meet the demand for professional soccer teams in the capital, such as Remo, Paysandu, and Tuna, in addition to amateur teams and sports players who usually go to the neighborhood to hold small private championships, favoring the market and encouraging this substitution in land use.

Despite the diagnosis made through geoprocessing, when images of 2006 and 2019 were compared, it was observed that changes between activities occurred subtly during this period. People who work with the rental of soccer fields claim that this phenomenon has occurred in neighborhoods for over 35 years. Unfortunately, identifying its inception is not possible given the absence of aerial images for periods before 2006. In the current 2019 scenario, this analysis accounted for 44 soccer fields across Curuçambá, which are geographically dispersed similar to the local UPA (Figure 2).

It is worth noting that one of the difficulties encountered in quantifying (via satellite and on locus) the productive units in the Curuçambá neighborhood is the spatial division of agricultural areas. Many properties do not have walled demarcations or markings that divide one production unit from another. Additionally, some spaces are shared by several farmers, which has prompted doubts regarding the quantification of agricultural areas.

In the interviews, however, information was obtained about the extension of properties and which of them were meant for agriculture. In the neighborhood, production occurs in residential units with planting areas ranging from less than 500 m^2 to 5.4 hectares (Table 3). Generally, the houses are owned by farmers, and in some cases, they are spaces for rent or a lending system (in the case of COPG members).

Table 3. Size of property areas and agricultural space of the production units with AUP in Curuçambá, 2019

Property Area	f_{ri} (%)	Agriculture	f_{ri} (%)
Up to 1,000m^2	19.05	Up to 500m^2	15.87
From 1,000m^2 to 5,000m^2	42.86	From 500m^2 to 1,000m^2	17.46
From 5,000m^2 to 10,000m^2	20.63	From 1,000m^2 to5,000m^2	38.10
From 10,000m^2 to 50,000m^2	12.70	From 5,000m^2 to10,000m^2	15.87
From 50,000m^2 to 96,0000m^2	4.76	From 10,000m^2 to 50,000m^2	11.11
		Above 50,000m^2	1.59
Total	100.00		100.00

Source: Research data.

As shown in Table 3, Curuçambá has relatively extensive land for an urban area, with 80.95% above 1,000 m^2. It is estimated that the agricultural areas in the neighborhood make up 87% of the extension of property areas on average.

Approximately 73.02% of respondents affirmed that they do not breed animals for commercial production or self-consumption, while 26.98% breed poultry, pigs, and fish in areas ranging from 72 m^2 to 756 m^2. These products are generally intended for self-consumption, except for pigs, which are bred in larger areas for commercialization. Poultry production is not aimed at serving markets because they are generally free-range animals with a later development time (about five months). Additionally, besides having a very specific consumer niche, they are not commercially profitable owing to production costs.

The main items produced were fresh vegetables and fruit. This is similar to the results often cited in the scientific literature regarding the UPA in the state of Pará (Madaleno, 2002; Santos and Silva, 2007; Araújo et al., 2017; Pacheco et al., 2018).

Production is aimed at supplying the RMB market, such as the street markets of PAAR, Cidade Nova 4, Entroncamento, and Ver-o-Peso. However, it seems that a small portion is intended for the self-consumption of the families involved in the activity. It is also worth noting that the production of the neighborhood is influenced by the demands of regional dishes typical of Pará cuisine, such as coriander, *jambu*, chicory, cassava, açaí, and cupuaçu, as shown in Table 4.

Table 4. Inventory of the main items produced by UPA in Curuçambá and the frequency of production units from July to September 2019

Popular name	Scientific name	f_{ri} (%)
Coriander	*Coriandrum sativum*	80.95
Jambu	*Acmella oleracea*	68.25
Chicory	*Cichorium intybus*	61.90
Lettuce	*Lactuca sativa*	47.62
Cariru	*Talinum triangulare (Jacq.) Willd.*	42.86
Basil	*Ocimum basilicum*	38.09
Chives	*Allium schoenoprasum*	33.33
Cabbage	*Brassica oleracea*	19.05
Mastruz	*Dysphania ambrosioides*	15.87
Cassava	*Manihot esculenta*	11.11
Açaí	*Euterpe oleracea*	6.35
Tilapia	*Oreochromis niloticus*	6.35
Banana	*Musa spp.*	7.94
Free-range Chicken	*Gallus gallus domesticus*	7.94
Cupuaçu	*Theobroma grandiflorum*	3.17
Hortelãzinha	*Mentha pulegium*	4.76
Malagueta Pepper	*Capsicum frutescens 'Malagueta'*	3.17
Swine	*Sus scrofa domesticus*	4.76
Parsley	*Petroselinum crispum*	3.17
Green Bean	*Vigna unguiculate*	1.59
Cucumber	*Cucumis sativus*	1.59

Source: Research data.

Note: The items highlighted in gray are products most used in regional cuisine.

Table 4 shows the relative distribution of agricultural products among the productive units in the neighborhood. Some crops, such as coriander, *jambu*, chicory, and cassava, are used in regional dishes, such as *pato no tucupi* ("duck in tucupi"), *tacacá*, *vatapá*, and *maniçoba*, which are widely consumed in restaurants, street markets, recreational spaces, and kiosks throughout the RMB.

It is worth noting that the survey data collection period preceded the Catholic festival of *Círio de Nossa Senhora de Nazaré*, one of the most traditional religious manifestations in Brazil, in which the city of Belém receives a large flow of tourists. This makes the production of vegetables such as *jambu*, chicory, and cassava more attractive and highly demanded in local gastronomy (during this period, Pará cuisine was driven by *tucupí*, *maniçoba*, *tacacá*, "*paraense*" rice, and *jambu* pizza, among others), whose dishes are prepared both by the families that prepare the traditional Círio lunch, as well as in the restaurants that receive tourists.

It has been theorized that urban agriculture is generally significantly influenced by the regionalist aspects of its food. In the case of Curuçambá, cultivation meets the food demands of the rich *paraense* cuisine. To prove this, the cases of Bon et al. (2010) and Mkwambisi et al. (2011) were observed for comparison.

In the study by Bon et al. (2010), at the top of the list of fresh vegetables supplied by urban agriculture in Africa and Asia are leafy vegetables such as Amaranth (*Amaranthus hybridus*), water spinach (*Ipoema aquatica*), vinegar (*Hibiscus sabdariffa*), red Ethiopian tomato (*Solanum aethopicum* and *S. nigrum*), cabbages, lettuces, onions, and tomatoes. In contrast, a study by Mkwambisi et al. (2011) on urban agriculture in Sub-Saharan Africa found that in addition to conventional products such as corn, eggs, and cattle, many urban farmers resort to the cultivation of some roots not only as a supplement for corn used in animal nutrition but also because the species used can grow without using inorganic fertilizers and can withstand drought in the region.

In addition to the food aspects, it is possible to observe that in the most diverse inventories of products grown by urban agriculture around the world, there is a dependence on cultures and the edaphoclimatic conditions of each region.

The quantity produced for each UPA product in the neighborhood was also obtained. The production estimate for Curuçambá is shown in Table 5, indicating that *jambu* culture prevails in the volume produced.

Table 5. Estimated production of crops cultivated by urban agriculture in the Curuçambá neighborhood, 2019

Crops	Production	Unit/time	Mean	Minimum	Maximum	Mode
Jambu	122,630	Sheaf/month	2,787.04	50	18,000	2,000
Lettuce	106,070	Sheaf/month	3,657.59	30	70,000	800
Coriander	58,915	Sheaf/month	1,178.30	30	10,000	800
Chicory	46,330	Sheaf/month	1,187.95	30	6,000	400
Cariru	37,110	Sheaf/month	1,325.36	10	6,000	400
Basil	11,160	Sheaf/month	465.00	20	2,000	200
Chives	6,450	Sheaf/month	339.47	30	2,000	200
Mastruz	4,240	Sheaf/month	424.00	10	1,500	200
Cabbage	3,391	Sheaf/month	308.27	07	2,000	200
Açaí	2,072	Can[1]/harvest	414.40	80	1,000	***
Cassava	1,020	kg/month	145.71	70	300	***

Source: Research data.

Observation (1): Estimated quantities for the 63 properties analyzed correspond to 52.5% of the existing production units in the neighborhood.

Observation (2): Typical regional cuisine products are highlighted in gray.

Observation (3): (***) means that there is no information.

Note[1]: One can is equal to 14 kg of fruit.

Despite not being exclusive of regional cuisine, lettuce has significant production in the local context owing to its high demand in the market. It was identified that 47.62% of the production units visited cultivated the species, with an average production of 3,657.59 sheaves/month and 800 sheaves at monthly intervals. It is important to highlight that the volume of 106,070 units of the product (26.42% of vegetable cultivation) is mainly attributed to more technified production, as in the case of hydroponic crops.

In addition to the regional crops presented at the top of the UPA of Curuçambá shown in Table 5, açaí and cassava crops were also observed in the list of local production. In the case of açaí, the presence of açaí groves was found in areas furthest from the urbanized area of the neighborhood. The production is also associated with the native extraction of the fruit, located in properties close to areas of tree vegetation found in the locality, as shown in Figure 2.

The production of cassava is generally conducted along with the production of vegetable plants and is intended for family consumption. The presence of ovens to produce cassava flour (*brava*) was not observed in any production system; therefore, the products, when commercialized, are sold *in natura* to the city markets.

Different technological models used in agricultural production in the Curuçambá neighborhood were identified. In Figure 3, six main production systems are identified (common beds, suspended beds, fruit cultures, agroforestry yards, hydroponics, and aquaponics), and in Table 6, their respective attributes are characterized: plant support structure; presence or absence of protected cultivation (plasticulture); soil analysis; organic and chemical fertilization; use of pesticides such as insecticides, herbicides, and fungicides; and irrigation systems and use of personal protective equipment (PPE).

Regarding the means of support, in common beds, fruit cultures, and agroforestry yards, the soil is used conventionally, except for suspended beds, in which the substrate is raised by wooden structures of about 1.00-meter-high, to facilitate the execution of horticulture management activities. In hydroponics and aquaponics, the use of this resource is not observed, and plant nutrition is provided by nutrient solutions and water circulation.

Table 6. General aspects of urban agriculture production systems in Curuçambá, 2019 (values in %)

PRODUCTION SYSTEM	PRACTICES									
	Plasticulture	Soil Analyzes	Organic Fertilization	Chemical Fertilization	Agricultural Machinery	Insecticide	Herbicide	Fungicide	Irrigation System	PPE
Only common beds (71.43)	Green house (1.59) Tunnels (15.87) None (53.97)	Yes (9.52) Done by EMATER EMBRAPA and UFRA	Manure (53.97) 10 to 200 bags used per month Compost (14.29) Up to 6 bags per month None (4.76)	Yes (20.63) Occasional use of Urea, NPK formulations, and foliar fertilizer.	Yes (1.59) Bed Tractor (COPG)	Yes (44.44) Cypermethrin 3% Sulfluramide Deltamethrin	Yes (19.05) Glyphosate Paraquat Dichloride	Yes (7.94) Not specified	Yes (1.59) Micro-Sprinkler	Yes (12.70) Only gloves, boots, and mask
Suspended beds (12.70)	Plasticulture (12.70)	Yes (3.17)	Manure (3,17) Compost (7,94)	Yes (3.17) Lime and NPK (10 – 28 – 20)	Yes (3.17) Bed Tractor (COPG) Mini Tractor	Yes (7.94) Cypermethrin 3% Sulfluramide Deltamethrin	Yes (1.59) Glyphosate	Yes (4.76) Copper Hydroxide for Pathogens of Jambu Crop	Yes (6.35) Micro-Sprinkler	Yes (4.76) Only gloves, boots, and mask
Fruit cultures (Monoculture) (6.35)	Not applicable	Yes (1.59)	***	***	***	***	***	***	***	***
Agroforestry yards (3.17)	Not applicable	Yes (1.59) Classification and Physical and Chemical analyzes made by EMATER.	Ashes and Vegetable Residues (3.17)	Yes (1.59) NPK and Urea	***	Yes (1.59) Cypermethrin 3%	***	Yes (1.59) Cypermethrin 3%	***	Yes (1.59) Only gloves and boots
Aquaponics (1.59)	Plasticulture (1.59)	***	Mamona (*Ricinus communis L.*) (1.59)	***	***	***	***	***	Aquaponics (1.59)	***
Hydroponics (4.76)	Plasticulture (4.76)	Yes (1.59)	Manure (3.17) About 100 bags per month	Yes (3.17) Foliar Fertilizer and recommendations from Report 180 IAC	Yes (4.76) Pumping system	Yes (4.76) Imidacloprid Azoxystrobin Deltamethrin	Yes (4.76) Glyphosate	Yes (4.76) Azoxystrobin	Yes (4.76) Hydroponic and Micro-Sprinkler	Yes (4.76) Full Equipment

Source: Research data.

Note: (***) not executed.

Figure 3. Urban Agriculture production systems in the Curuçambá neighborhood, 2019

Source: Research field register.

Plasticulture is practiced within production systems in different ways and is a mechanism used to control the environment's temperature, solar radiation and phytopathogens. In bed production, this technique is used for tunnels (15. 87%), suspended beds (12.70%), hydroponics (4.76%), and aquaponics (1.59%); it is considered an investment added to the system as a whole, applying in all cases. In contrast, fruit cultures and agroforestry yards do not use this mechanism, even for the production of seedlings as they cultivate long-cycle and large species such as açaí, cupuaçú, and banana.

Regarding the soil analysis procedure, only 17.46% claimed to have submitted material from the property for evaluation, executed by organizations such as *Empresa Brasileira de Pesquisa Agropecuária* ("Brazilian Agricultural Research Corporation" - EMBRAPA), *Empresa de Assistência Técnica e Extensão Rural do Pará* ("Technical Assistance and Rural Extension Company of Pará" - EMATER-PA), and *Universidade Federal Rural da Amazônia* ("Federal Rural University of the Amazon" - UFRA). In contrast, 82.54% of neighborhood producers never conducted the process, and among those who did, some claimed that they never received the results.

Organic fertilization mainly used poultry litter (60.31%), concentrated for production in beds, and suspended cultivation. The composting technique (22.23%) was further used to improve the soil's physical, chemical, and biological properties. A positive aspect is that, unlike the observations made by Araújo et al. (2017), the practice of itinerant agriculture was inexpressive in the neighborhood owing to the limited space in more urbanized areas and specialization for açaí extraction activities in forest areas.

In fruit cultures and agroforestry yards, the use of residues generated by the vegetation and ash from burnt materials was observed. However, regarding plant nutrition, using other more efficient fertilization alternatives, such as those presented for other production systems, is incipient.

Chemical fertilization is occasionally used in less-technified production systems, mainly the use of urea, nitrogen, potassium, and phosphorus (NPK) formulations; limestone; and foliar fertilization. Some farmers claim not to use this type of fertilizer, as they believe it allows the accelerated growth of plants with their subsequent weakening. In contrast, due to the dependence on water and mineral nutrition of plants in nutritive solutions, hydroponics has constant use of these fertilizers with greater control, highlighting the agronomic recommendation presented in Technical Report 180 from the Agronomic Institute of Campinas, developed by Furlani et al. (1999).

Unlike other systems, according to Anammasiya et al. (2019), the productivity of hydroponic systems is 100 times higher than the agricultural productivity developed in the field, allowing cultivation in limited spaces with efficient use of water and chemical resources.

Generally, producers do not use machinery to execute agricultural practices. They use technologies that require manual effort. Accordingly, only those closest to COPG management have access to small tractors. This research asserts that a water pumping and recirculation system is present in hydroponics and aquaponics as a form of agricultural mechanization specific to these models. In this sense, it was found that 14.29% of producers invested in technology to improve water management. Moreover, the implementation of micro-sprinklers has been observed mainly in suspended beds.

Notably, 53.97% of producers use insecticides such as cypermethrin (3%), deltamethrin, and sulfluramide to control insects such as ants, nestlings, and caterpillars. Generally, weed control is done manually. However, in some cases, to facilitate the opening of beds, farmers use herbicides (20.64%), such as glyphosate and paraquat dichloride, which are products classified as moderately and extremely toxic, respectively.

In addition to these pesticides, in 19.05% of the cases, fungicides are used to control phytopathogens, mainly for lettuce and jambu crops. In the field survey, the presence of diseases such as tospoviruses ("vira-cabeça") and fusariosis (*Fusarium oxysporum*) in lettuce crops was identified; in jambu crops, copper hydroxide was used to control for unspecified diseases.

The use of pesticides is usually defined based on a very empirical diagnosis and occasional use in less technified systems, whereas in systems such as hydroponics, their use is strictly controlled and has a greater frequency of applications. Even if applied occasionally, in scenarios with less technological improvement, there are problems related to little knowledge of the producers regarding the safety period for the application of pesticides.

It is also worth noting that in less technified systems, drifting from the application of pesticides is often not considered, which can be harmful to the health of the local community as the wind can direct a residual portion of products into their homes. According to Orsini et al. (2013), pesticide contamination is one of the main negative aspects of urban agriculture in developing countries. However, this issue is better controlled in hydroponic systems because the properties are walled, and the flow of these products is almost completely contained in the production unit.

It was found that the use of PPE is precarious in scenarios of less improved technology, with only masks and gloves being used, which does not happen in hydroponics, where full equipment use is strictly monitored by managers of these ventures.

In a general contextualization regarding urban agriculture in Curuçambá, it appears that within the productive units, there is a "mixing" between different production systems in many cases, that is, the aggregation of two or more categories of production models. In the properties visited, soil resources were not necessary in only 1.59% of cases because of the hydroponic system.

Production spaces are limited, making it impossible to adopt fallow periods to recover the physical, chemical, and biological properties of the soil. After several planting cycles, there is a reduction in the fertility of this resource; in this context, producers apparently do not adequately replace nutrients in the soil. It was observed that farmers lacked technical information for planting management, and 55.56% of respondents never sought or received any technical assistance.

In contrast, 44.44% of them received some type of technical assistance, with 14.29% receiving instructions weekly and 30.16% more times a month or sometimes assisted by technicians. One of the main problems faced by urban agriculture in the Amazon is the lack of technical assistance and little space for production (Silva and Sablayrolles, 2014).

Plantation management techniques are, in many cases, performed in an empirical and sometimes lay manner, with inadequate spacing for the development and productivity gain of some crops, which is the main problem observed in coriander, *jambu*, and *açaí* plantations, where there is no standardization of the crop.

Although agricultural practices are highly productive in hydroponic cultures, some limiting problems have been reported in this system. Among these is the spending on electricity. As it is an urban area and there is a lack of public policies adopted for this model of agriculture, it was reported that the use of electricity is charged in the same way as the rest of the residential areas in the region. As farmers do not have access to a system suitable for their needs, this may be an interesting demand for COPG to work with electric power supply companies or even the state government.

Despite being innovative owing to the increased efficiency of resource use and space optimization, aquaponics systems have already fallen into disuse owing to the lack of practicality from the farmers' perspective. For both hydroponics and aquaponics, water is obtained from artesian wells, a factor that increases production costs in both models owing to electricity expenses.

3.4 Family Self-consumption of UPA Products

An assessment of the opportunity costs of self-consumption of food from products grown on family properties was conducted in a complementary manner. Monthly family expenses with food vary from R$150.00 to R$1,500.00, representing an average of 30.89% of the total income of each production unit. In proportional terms, these expenses are higher for less-favored social strata and milder for those with higher income, as shown in Table 7.

Table 7. Costs with food according to monthly family income

Monthly family income		(%)	Costs (R$)
Up to a Minimum Wage (R$ 954.00) (25.40% of the sample)	Minimum	15.72	150.00
	Average	38.33	365.63
	Maximum	62.89	600.00
1 to 2 Minimum Wage (R$ 954.00 to R$ 1,908.00) (50.79% of the sample)	Minimum	15.72	300.00
	Average	30.39	579.88
	Maximum	78.62	1,500.00
2 to 3 Minimum Wage (R$ 1,908.00 to R$ 2,862.00) (11.11% of the sample)	Minimum	17.47	500.00
	Average	30.45	871.43
	Maximum	55.90	1,600.00
3 to 4 Minimum Wage (R$ 2,862.00 to R$ 3,816.00) (7.94% of the sample)	Minimum	13.10	500.00
	Average	26.03	993.40
	Maximum	39.31	1,500.00
4 to 5 Minimum Wage (R$ 3,816.00 to R$ 4,770.00) (1.59% of the sample)	S.V	8.39	400.00
10 to 26 Minimum Wage (R$ 9,540.00 to 24,804.00) (1.59% of the sample)	S.V.	8.39	800.00
26 Minimum Wage (R$ 24,804.00) (1.59% of the sample)	S.V.	6.05	1,500.00

Source: Research data.

Note: (S.V.) Standard value in minimum, average, and maximum.

Mougeot (2005) and Orsini et al. (2013) indicated that low-income families in cities spend between 50% and 80% of their income on food and still do not meet their daily nutritional needs. A study conducted in Belém by Madaleno (2002) showed that the poorest families spent about 1/3 (33.33%) to 2/3 (66.67%) of their income on food, which is congruent with the information presented in this work.

In addition to what is shown in Table 7, information about the quantity of products cultivated in the production unit was collected. However, in most cases, farmers had no control over the quantity of items used for family feeding, making it difficult to understand this issue economically.

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All study participants were asked about food consumption from their own production. However, as they did not obtain a percentage value that would make the information more precise, it was decided to complement the data by analyzing the consumption of six families that agreed to help. Table 8 shows the consumption patterns of vegetables produced by the families. These data made it possible to make some consumption proportions through the market garden size and opportunity cost of items, such as coriander, *jambu*, lettuce, chicory, and *cariru*.

Table 8. Monthly feeding consumption of items produced by six families in Curuçambá neighborhood

	Family 1		Family 2		Family 3		Family 4		Family 5		Family 6	
Crops	Un.[1]	R$	Un.	R$	Un.	R$	Un.	R$	Un.	R$	Un.	R$
Coriander	12	27.00	22	49.50	16	36.00	25	56.25	22	49.50	16	36.00
Cabbage	10	13.33	-	-	2	2.67	-	-	10	13.33	10	13.33
Chives	-	-	10	26.67	10	26.67	-	-	4	10.67	-	-
Chicory	-	-	2	3.38	8	13.50	-	-	14	23.63	-	-
Cariru	-	-	-	-	2	2.33	-	-	4	4.67	4	4.67
Lettuce	-	-	4	6.33	-	-	-	-	10	15.83	-	-
Cucumber	-	-	-	-	-	-	-	-	10	33.75	6	20.25
Jambu	12	21.00	-	-	-	-	-	-	-	-	4	7.00
Basil	-	-	2	4.00	-	-	-	-	-	-	-	-
Economy (R$)		61.33		89.88		81.17		56.25		151.38		134.25
Residents		6		6		5		4		3		1[2]
P.S.[1]	C.B.[1]		C.B.		C.B.		C.B.		S.B.[1]		S.B.	
Produced Items	• Lettuce • *Basil* • *Capim Santo* • *Catinga de Mulata* • *Chegate a mim* • Coriander • Chicory • Cabbage • Estoraque • *Hortelãnzinho* • *Jambu* • *Mastruz* • *Vick*		• Lettuce • *Basil* • *Chives* • Coriander • Chicory • *Jambu*		• Lettuce • *Cariru* • *Chives* • Coriander • Chicory • *Hortelãnzinho* • *Jambu*		• Coriander		• Lettuce • *Cariru* • Coriander • Chicory • Green Bean • *Jambu* • Cucumber		• Lettuce • *Chives* • Coriander • Chicory • Cabbage • Green Bean • *Jambu* • Cucumber • Okra	

Source: Research data.

Note[1]: Abbreviations: unit (n), Production System (P.S.), Common Beds (C.B), and Suspended Beds (S.B.).

Note[2]: Female farmer who resides in a collective production that uses resources from her own production to feed other partner farmers.

Observation[1]: In the class "Produced Items," the bolded and underlined items, are items consumed from production.

Coriander is often used as a condiment for daily meals throughout the region. This is considered one of the most used products in farmers' family meals in the neighborhood. Only 12.70% of the interviewees established percentage values of consumption of items that were congruent with information obtained from the six families. Therefore, it is estimated that the consumption of coriander in the production of 812.5 sheaves per month (p.m.) is 2.63%, equivalent to 17.38 sheaves/month on average. As the product was being sold at R$ 2.25 per sheaf at RMB street markets during the period from July to September, a saving of R$ 39.09 was suggested within the analyzed values for that time interval through the self-consumption of the product.

Regarding the *jambu* culture, it is shown that 25.40% were able to quantify consumption in a similar way to the analysis made in Table 8. It is estimated that, in a culture production of 673.75 sheaves per month, the consumption accounts for approximately 1.31% on average, which in absolute values is equivalent to 7.99 sheaves per month. The average retail cost was R$ 1.75. Therefore, the saving for the product was estimated at R$ 13.89/month. Lettuce consumption was consistent with 26.98% of respondents. The proportion was that in a production with an average of 531.76 sheaves per month, the consumption was 1.29%, equivalent to 6.81 sheaves per month. The product price was R$ 1.58, saving R$ 10.79 monthly.

Another product used as a spice in regional foods is chicory (30.16% congruence). In the production of 538.95 sheaves/month, the proportional average consumption was 1.24%, equivalent to 5.78 sheaves per month, saving R$ 9.76 monthly, according to the price in the period, R$1.69. For *cariru* (17.46% congruence), the estimated proportion was 590.91 sheaves/month, with a consumption of 1.05%, equivalent to 5.36 sheaves/ month, which saved R$ 6.26 in the analyzed period, when the product was R$ 1.17 a sheaf.

Establishing the worth of opportunity cost, it is estimated that by consuming the five main products grown in their own yards, the producer from Curuçambá saved R$ 79.88 per month, equivalent to 8.37% of the minimum wage at that time.

4. Conclusions

The UPA practiced in the Curuçambá neighborhood has been improving technologically through the implementation of production systems that achieve greater productivity in small areas of the properties and with technologies such as plasticulture, organic fertilization, investment in irrigation automation, and even the adoption of systems that are not implemented on the ground, such as hydroponics and aquaponics.

It is worth noting that this activity has been competing with the real estate market and expansion of soccer fields for rent per match, which end up being more profitable and having less maintenance and management effort.

Additionally, the activity has proven to be strategic for the economy and food security of its practitioners in Curuçambá, benefiting the farmers and offering expansion of horticulture products in the local market, mainly those used in the local cuisine, such as *jambu*, coriander, chicory, *cariru*, and lettuce.

Despite the positive aspects, the segment still lacks technical assistance and specific public policies to meet the demands of these farmers. The creation of competitive advantages would be an essential mechanism to reinforce short-circuit production practices, which would raise the quality of products sold and reduce the food cost on the consumer’s table.

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