Rural Science and Technology in Territories under Conflicts on Amazon - The Case of Ipaupixuna Village

Ciência e Tecnologia Rural em Territórios sob Conflitos na Amazônia - O Caso da Vila Ipaupixuna

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ABSTRACT
Thinking about science and technology in rural niches in the Amazon naturally translates into an interdisciplinary act in the face of numerous socio-environmental and economic challenges. Thus, scientific knowledge more than ever, should now contribute to resistance to traditional peoples in the Amazon in the face of illegal deforestation, burning and soybean expansion over indigenous and quilombolas territories. Under this landscape of social conflicts and environmental degradation, with serious economic damage to traditional populations, it is therefore up to science and rural technology to innovate to resist, but, an innovation that transcends scientific or technological aspects and that strongly carries solidarity and entrepreneurship. A new way of doing science and technology in the middle of the forest and in the 21st century is necessary, this form, which is expressed in trinomials such as *science-solidarity-entrepreneur* or *technology-solidarity-entrepreneur*. The objective of this research was to create theoretical models of Conservation and Production Systems of certain plant species of high Use Value for indigenous families of the Ipaupixuna-Etnia Munduruku Village. The methodology used consisted in the analysis and use of data from the ethnobotanical and floristic survey of Ipaupixuna Village and consequent elaboration of a set of scientific-technological-solidarity models. The results were the creation of two (2) Species Conservation Centers, *in situ* and *on the farm*; two (2) production models focused on economic exploitation, such as Medicinal Forests and Etnogardens and finally 3 (three) units of processing plants aimed at the technological increase of plant extraction (*Techextractivism*).

Keywords: Agrarian sciences, Munduruku, Agroextractivism.

RESUMO
Pensar em ciência e tecnologia em nichos rurais na Amazônia se traduz naturalmente em um ato interdisciplinar diante de inúmeros desafios socioambientais e econômicos. Assim, o conhecimento científico, mais do que nunca, deve agora contribuir para a resistência dos povos tradicionais da Amazônia diante do desmatamento ilegal, das

queimadas e da expansão da soja sobre territórios indígenas e quilombolas. Sob este cenário de conflitos sociais e degradação ambiental, com graves prejuízos econômicos para as populações tradicionais, cabe portanto à ciência e à tecnologia rural inovar para resistir, mas, uma inovação que transcende os aspectos científicos ou tecnológicos e que carrega fortemente a solidariedade e o empreendedorismo. Uma nova forma de fazer ciência e tecnologia no meio da floresta e no século XXI é necessária, esta forma, que se expressa em trinômios como ciência-solidaridade-empresário ou tecnologia-solidaridade-empresário. O objetivo desta pesquisa foi criar modelos teóricos de Sistemas de Conservação e Produção de certas espécies vegetais de alto Valor de Uso para famílias indígenas da Aldeia Ipaupixuna-Etnia Munduruku. A metodologia utilizada consistiu na análise e utilização de dados do levantamento etnobotânico e florístico da Aldeia Ipaupixuna e conseqüente elaboração de um conjunto de modelos de solidaridade científico-tecnológica. Os resultados foram a criação de dois (2) Centros de Conservação de Espécies, in situ e na fazenda; dois (2) modelos de produção focalizados na exploração econômica, tais como Florestas Medicinais e Etnogardens e finalmente 3 (três) unidades de plantas de processamento destinadas ao aumento tecnológico da extração de plantas (Techextractivismo).

Palavras-chave: Ciências Agrárias; Munduruku; Agroextractivismo.

1 INTRODUCTION

The contemporary Amazon with its beauty that goes beyond biodiversity and extends through the rich knowledge of traditional populations, such as indigenous and, quilombolas, who have historically lived in the forest peacefully and almost always forgotten by the public authorities, experiences not only local and global climate change, but above all, conflicts over land ownership. These conflicts, which according to Castro et al (2017) are based on land grabbing over the territories of traditional populations, highlighting the importance of the participation of social movements in the construction of the resistance process. The fragility of the Agrarian Reform implemented in the Amazon Biome caused by the pressure of exogenous productive groups to the region, capital pressure on biodiversity, on the soil and climate of the region, has made and still makes the Amazon region a permanent agricultural frontier, where landscape change is inevitable and at accelerated paces. It is in this context, however, that the practice of a Rural Science and Technology aimed at vulnerable traditional Amazonian populations is urgent, as a solidarity, mitigating or reparative form of the productive systems of these peoples affected by landscape changes (Oliveira 2020).

In this scenario, there are four (4) components completely intertwined and that should be carefully analyzed. The first(1) component is the Indigenous Territories (TIs) distributed along the rivers in the Amazon Hydrographic Basin with their populations of the most diverse ethnic groups, which maintain their traditions and their ways of life and have in the Forest, their space for income production and survival, where through the centuries-old practices of sustainable plant extractivism challenge the deforestation scenarios that intermittently threaten their ecosystems, such practices therefore be considered agroecological. However, differently from what De Souza Maciel et al (2009) place as agroecological practices for lowland farmers, where the author reports the alternative management of pests, the concorporated planting and the management of soil organic matter. Thus, ethnicity in agriculture and agroextractivism has a direct influence on the different modes of land use and natural resources in the Amazon.

Indigenous populations lose not only physically and or spatially their territories but lose over time the traditional knowledge associated with this biodiversity which is under threat. Losses are therefore material and immaterial, in space and time. Reports from *the Public Agency,* an investigative journalism agency in its series *Amazônia sem Lei* portrays very current threats with hydroelectric projects in indigenous territory in the Santarém Plateau, and that according to Braganca (2019) in its quantitative analysis of the social actors involved in this problem, noted that most are opposed to the implementation of hydroelectric. The fact is, the rich diversity, not only of terrestrial organisms, but, aquatic too, are threated in some indigenous territories and in accordance to Bevilaqua (2020) the environmental DNA, called eDNA has emerged as an effective method for detecting aquatic organisms, that could be function like a bioindicator of sustainability levels.

O second (2nd) component are soybean *(Glycine max)* producers who arrived from the south of the country and settled in the Amazon in recent decades seeking land with low and fertile prices and it is at this moment that the change of landscape happens gradually and invariably. This scenario is still based on the frontier economy, which according to Kenneth Boulding (1966) conceptualizes it in an economic growth seen as linear and infinite, based on the continuous incorporation of land and natural resources, which are also perceived as infinite (*Cowboy Economy*). However, for Boulding the antithesis was the *Astronaut's Economy,* where he regarded our planet metaphorically as

a *ship* with limited resources, where production and consumption are no longer the goals but rather environmental conservation, cyclical production and sustainability as a result. And this is what we see today in the Tapajós River region, the expansion of the soybean economy *(Cowboy Economy)* on humid tropical forest ecosystems with drastic loss of biodiversity a loss this irreversibly. As Becker (1982, 1987, 2004, 2013 and 2015) pursuit, the Amazon, Brazil, and the other Latin American countries are the oldest peripheries of the capitalist world system, and it is necessary to break the paradigm of the current perverse society-nature relationship.

The spatialization of soybean plantations goes far beyond degraded land used by livestock or logging (Domingues, 2012) but rather, they are implanted directly over forested areas, in a process of drastic conversion of local and regional phytophysionomy, where forests are replaced by extensive soybean monocultures. This cultivation carries with it a heavy agrotechnological package in fertilizers and pesticides peculiar to agricultural culture and extreme ecological disturbance, regarding the relations between soil, plant and atmosphere. This conversion of landscape, soybean forest, at a more micro level, represents severe floristic change, diversity, soil structure and fertility, soil mesofauna, carbon stock, pollinators, greenhouse gases, among others. According to Santos et al (2017) the accelerated and disordered conversion of forests into the agricultural frontier areas of the Brazilian Legal Amazon in the last four decades resulted in a fragmented landscape, which connectivity and maintenance of biodiversity in the remaining forest fragments is low, but necessary to do.

However, it is the social disturbance in *niches* such as forest populations, *that knocks* on the door of the sensitivity of scientists, or at least some, motivating epistemological curiosity in the search for scientific-technological solutions to one of the greatest challenges of science and technology in the contemporary Amazon, equating economic development with socio-environmental justice.

A third ($3^{o)}$ component of this scenario is the very biodiversity of forests in indigenous territories which are historically used for the main economic activity of these populations, which are plant and animal extractivism. With emphasis on plant extraction, forest ecosystems provide the villages of fruits, seeds, fibers, wood, oils, resins and medicinal plants (Oliveira, 2017_1, Oliveira 2017_2) above all. Thus, to think about science and technology for traditional populations is to think about the processing of these plant

resources in more sophisticated products, and with greater added value, therefore, thus favoring the income of these peoples. In other words, science and technology in Amazonian contexts can contribute to a transparent transition between the *fresh product* and the *benefited product* to be sold by traditional populations, which can be embedded with a minimum of technology in a first stage and at a near level with high aggregate technology. It is necessary that biodiversity is seen not in a contemplative way, but in a productive way in indigenous territories, so that these populations can one day be economically sustainable and not dependent on federal government grants, as it happens today.

A fourth(4th) important component in this science and technology scenario *in* indigenous Amazonian niches is traditional *knowledge* built through orality among the many generations in recent centuries. This traditional knowledge mainly about medicinal plants, always validated by phytochemical and pharmacological research is an immaterial good with high value for traditional populations but which is most often hidden in research, which omits the source of this traditional knowledge about given plant, which is only revealed in ethnobotanical studies. Ethics in research can often be responsible for inequalities in product markets arising from Amazonian biodiversity, which needs to be reviewed and jointly resolved. The monetary or non-monetary valuation of immaterial goods, such as the traditional knowledge of Amazonian populations needs to be discussed, because biopiracy has shown the disaster that is not to put into practice fairer economic models. In addition, traditional knowledge also evolves, improves and blends with new knowledge, given that such populations are not isolated, on the contrary, they interact with universities and other groups, resulting in new knowledge, which does not prevent dialogue with science and technology, but rather warms and boosts the sustainable development of traditional peoples in the 21st century Amazon (Oliveira et al 2017[3], Oliveira 2017[4]).

Thus, the four components are strongly interconnected, where the *environmental component* is the link or interface between two other components or social groups, the traditional populations on one side and the soybean producers on the other, with completely different modes of use of agro(eco) systems. In turn, the traditional knowledge component is strongly intertwined with traditional populations, which in a way configures a binomial, *traditional knowledge /traditional populations* inseparable

and that has its existence in the environment. Any disturbance therefore in the environment and landscape of indigenous territories or quilombolas will undoubtedly generate the risk *of genetic* erosion of certain plant species, but the most serious and difficult to repair, the *erosion* of traditional knowledge. It is in this challenging Amazonian overview that science and technology are confronted every day, in search of solutions that are not definitive, but easing the current socioeconomic inequalities for traditional populations.

The objective of this research was therefore to develop theoretical models where the *science-solidarity-technology* trinomial in indigenous environments in the Amazon was possible through the creation of new spaces focused on both conservation and the productive aspect of forests, such as *medicinal forests* and *ethnogardens* (Oliveira & Sousa, 2020), as well as the practice of a more modern plant extractivism with technological contribution capable of making socioeconomic inclusion of extractive populations in fairer markets. The purpose of this research is also to put on the schedule, the Extractivism Value Chain in current scenarios where there is no fair market practice for these traditional populations.

2 METHODOLOGY

This work was theoretical in nature where from the bibliographic review associated with research and field experience with traditional populations in the last 20 years in the Amazon Biome, specifically in the territory of the Lower Amazon, Pará, Brazil, a set of scientific-technological-solidarity models capable from the plant resources of the Forest, of contributing to the socioeconomic development and environmental conservation in territories under conflicts in the Amazon was elaborated. The study area to which the models created were the Ipaupixuna Indigenous Village, of Munduruku ethnicity, where previous diagnoses had already been made (Oliveira, 2020, Oliveira e Sousa, 2020). This Village is one of the four Munduruku indigenous areas of the Santarém Plateau, the others are Açaizal, São Francisco da Cavada and Amparador, are known as Mundurukus of the Plateau.

The Mundurukus are indigenous people who live village but relatively close to the city of Santarém. Typically, they are agroextractivists, where the cassava *(Manihot sculenta)* culture is the main crop planted, being therefore 99% extractive, where they collect their other foods, medicinal plants, fruits, woods, oils among other products from

within the Forest. In this context, the Forest gains another dimension, that of the survival of indigenous peoples in remote areas. However, this indigenous territory is not yet legally delimited, which brings to light conflicts with soybean producers that expand towards their territory, with their heavy technological packages of fertilizers and pesticides (Rego & Vieira, 2017). The slow ness in the process of territorialization processes of indigenous areas (Barros 2019) has caused serious environmental damage, but especially social, often irremediable.

Considering the context of the research above, the dynamics of the work followed this sequence:

1. Documentary analysis: the results of two recently published scientific articles on the floristic composition of a given forest in Ipaupixuna Village, as well as on the ethnobotanical diagnosis were analyzed to support the construction of the new models of science and technology to be proposed. The scientific articles as the basis for the construction of the models were: a- Traditional Knowledge of Forest Medicinal Plants of Munduruku Indigenous People (Oliveira & Sousa 2020 [1]); b- Floristic Diversity in Secondary Forest under Munduruku Indigenous Agroextractivism (Oliveira & Sousa 2020[2]).;

2. Theoretical elaboration of science and technology models for the indigenous population of Ipaupixuna based on the following aspects: 1. Local floristic richness; 2. Ethnobotanical Survey; 3. Expectations of the indigenous families involved; 4. International market of natural products.

The working hypothesis used was that the process of creating theoretical models of science and technology with the feeling of solidarity as a basis would be able to produce theoretical models applicable, productive and sustainable in contexts under conflicts in the Amazon.

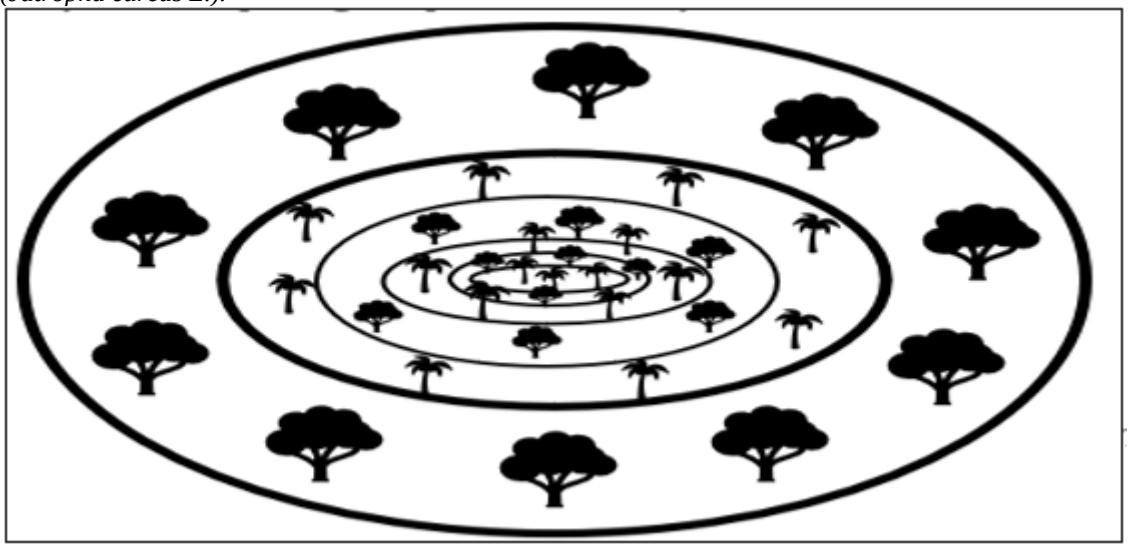
3 RESULTS & DISCUSSIONS

The results of this research were six theoretical models that corresponded to new spaces of conservation of plant diversity, production, survival and resistance of traditional populations in the Amazon, which can be implemented based on the principles of biodynamic agriculture in areas under conflict (or not) as a form of empowerment of these threatened peoples. These models were distributed in two categories:

3.1 PLANTING MODELS FOCUSED ON THE C*ONSERVATION OF FORESTS IN* IPAUPIXUNA VILLAGE:

3.1.1 In situ Conservation Centers of fruit/medicinal species pointed out in an ethnobotanical survey: This theoretical model of *Mandala* type nucleus would be located within the *forest (in situ) and would* have a *concentric* circular structure, mandala type, where the planting of fruit/medicinal species identified in the ethnobotanical survey would take place in concentric circles, where each circle would be represented by a fruit or medicinal species, as shown in Figure 1. The function of this Nucleus is to maintain the genetic material of fruit/medicinal species of importance to the indigenous village pointed out in the ethnobotanical survey as of high value of use to families, so they will not be for exploration but rather landscapes for conservation.

Figure 1- Theoretical model in Concentric Circles of the Nucleus of Conservation in *situ of* fruit/medicinal species* pointed out as of high use value for indigenous families in an ethnobotanical survey carried out in the Ipaupixuna Village, where in each circle is a species* 1 - *Thick Leaf/Malvarisco (Plectranthus amboinicus (Lour.) Spreng.); 2 – Jucá (Caesalpinia ferrea Mart. ex Tul.); 3 - Garlic (Allium sativum L.); 4 - Gengibre/Mangarataia (Zingiber officinale Roscoe.); 5 – Limão (Citrus limon (L) Burm.); 6 - Manga (Mangifera indica L.); 7 - Crajirú (Fredericia chica (Bonpl.) L.G. Lohmann); 8 - Abacate (Persea americana Mill.); 9 - Ipê roxo (Handroanthus impetiginosus (Mart. ex DC.) Mattos); 10 – Pião branco (Jatropha curcas L.).*



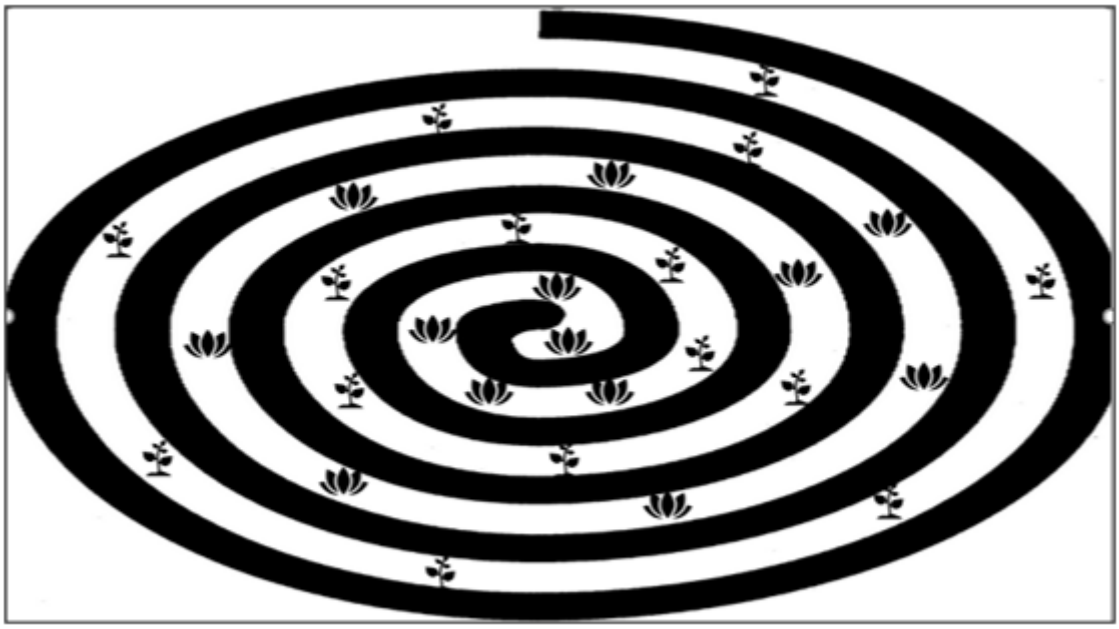
Considering the threats to the Indigenous Territory of Ipaupixuna by the advance of soybean crop, it is expected concomitantly that the forest ecosystems of lowland and dry land are in danger of deforestation and burning, most often, not accidental, culminating in the drastic change of landscape, that is, from forests to monoculture soybean. Thus, the proposed theoretical model of *in situ conservation center of*

fruit/medicinal species becomes an alternative space to mitigate the genetic loss that always accompanies the loss of floristic diversity in the processes of environmental devastation in the Amazon. In addition to this function, *the Center for in situ* conservation of fruit species will also function as a production site for sexual and asexual propagules for the formation of new orchards.

However, the educational function that this *theoretical* model of Conservation Center in situ can have in the Ipaupixuna Village on indigenous youth and adults, is valuable, given, that all species will be identified under the aspects of taxonomy and ethnobotany, which will allow the socialization *of scientific knowledge in locus* generating belonging to these peoples of their own rich traditional knowledge, now expressed in a new space, the *Nucleus of Conservation in situ of* fruit species. The visualization of one's own knowledge, that is, the fruit plants mentioned, which are the elements of the Mandala Nucleus, expressed in a single model of planting in mandala, is to make these indigenous people's protagonists of their own development.

3.1.2 *On farm* Conservation Centers of medicinal/aromatic species pointed out in ethnobotanical survey: such nucleus would be in agricultural areas (on *farm) in indigenous territory,* where only medicinal species would be planted which obtained high priority (Rank Order Priority) for the families of The Ipaupixuna Village according to studies by Oliveira & Sousa (2020). This Conservation Center on farm *would* also have the function of Conservation of Genetic Material of these Medicinal Plants and therefore would not be for consumption; it would also be based on biodynamic agriculture, where aspects such as agroecosystem diversity, crop rotation, composting and moon phases throughout the crop cycle should be observed. The structure of the Nucleus would be spiraled according to Figure 2.

Figure 2- Theoretical spiral model of the On Farm Conservation Center of medicinal and aromatic species* pointed out as priorities in ethnobotanical survey in Ipaupixuna Village in Santarém, Pará. * at each complete turn of the spiral is a medicinal species. ** 1 – Cumaru (Dipteryx odorata (Aublet.) Willd.); 2 - Lemon (Citrus limon (L) Burm.); 3 - Uxi amarelo (Endopleura uchi (Huber) Cuatrec.); 4 - Capim Santo/Lemon Grass (Cymbopogon citratus (DC.); 5 - Unha de Gato (Uncaria tomentosa (Wild) DC); 6 - Jucá (Caesalpinia ferrea Mart. ex Tul.); 7 – Thick Leaf/Malvarisco (Plectranthus amboinicus (Lour.) Spreng.); 8 - Ipê roxo (Handroanthus impetiginosus (Mart. ex DC.) Mattos); 9 - Sara-tudo (Justicia acuminatissima (Miq.) Bremek.); 10 - Gengibre/Mangarataia (Zingiber officinale Roscoe.).*



This theoretical model of *the Center for Conservation on farm of medicinal* and aromatic species in spiral aims to support the production chain of medicinal and aromatic plants in the Amazon region still little explored by the traditional populations themselves. What is currently observed are large multinational cosmetics and pharmaceutical companies that obtain the plant material from the Amazon forests at very low prices, therefore *in natura*. It is in this context of economic inequality that this scientific research intervenes, helping traditional populations to reverse this situation towards the gradual construction of a fair *trade* for the production chain of medicinal and aromatic plants. Meanwhile, *on-farm conservation models such* as this one proposed for medicinal and aromatic plants genetically preserve this diversity of these specific groups of plants, which are extremely important culturally and in the health of indigenous populations, where therefore, the trinomial culture-health-agriculture becomes inseparable. This theoretical model of *the Center for conservation on farm of* medicinal and aromatic species would preserve the diversity of these species cited by the indigenous as priorities

and diagnosed in the ethnobotanical study, thus avoiding the genetic erosion of these groups of plants in contexts of territorial threats, as is the case.

The choice of the site to be implanted this *On Farm Center of Conservation of* medicinal and aromatic species can be strategic as in areas ciliary to the stream and rivers that have suffered deforestation, thus fulfilling the ecosystem function as well. In accordance with Maracahipes-Santos (2020) the riparian forests play key roles in protecting biodiversity and water resources, but fragmentation associated with expanding tropical croplands threatens their ecological integrity. The authors compared the structure of tropical riparian forests within intact and cropland catchments in a region of intensive soybean production in the southeastern Brazilian Amazon and they found that riparian forests in croplands harbored fewer species of trees and seedlings/saplings, and had higher proportions of opportunistic, pioneer tree species.

In both models, that is, in both nuclei (centers), the purpose is the same, conservation of plant species of high use value and priority to indigenous peoples in the face of threats on their territories, considering that the existence of these nuclei in the threatened territory itself, makes them instruments-poles of resistance of traditional populations.

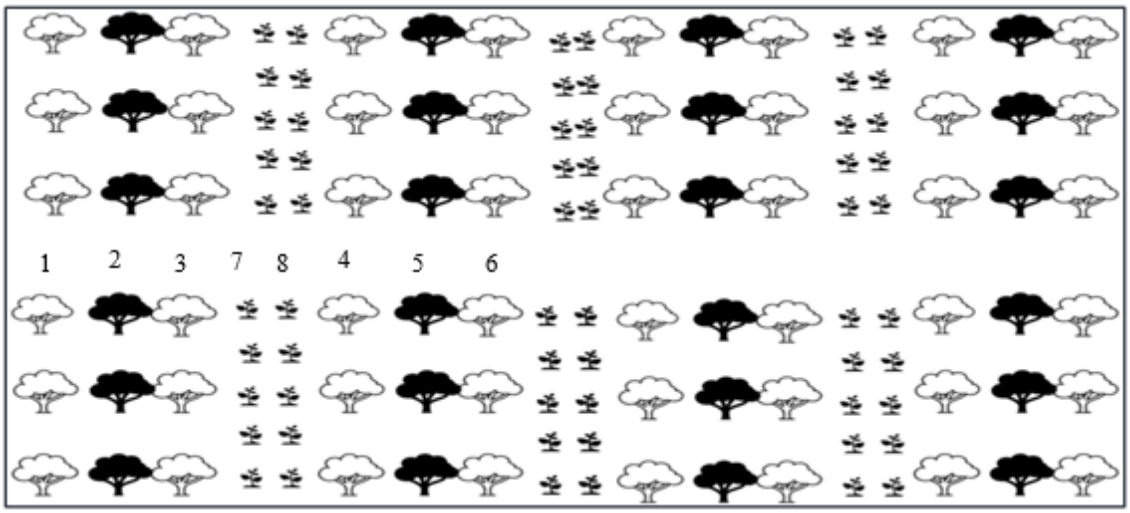
3.2 PLANTING MODELS AIMED AT THE *ECONOMIC EXPLOITATION OF* MEDICINAL & AROMATIC PLANTS IN IPAUPIXUNA VILLAGE:

3.2.1 Medicinal & Aromatic Forests: They are theoretical models of new planting spaces first proposed by Oliveira (2020) where only medicinal and aromatic plants are planted, and such selected plants were the species with the highest Use Value cited by the families of The Ipaupixuna Village, as demonstrated by the ethnobotanical work of Oliveira e Sousa (2020). Medicinal and Aromatic Forests, unlike conservation centers, are spaces for an agrossilviculture only of medicinal and aromatic plants. Considering the high market demand for essential oils, resins and medicinal plants from the Amazon Biome associated with the indigenous peoples' traditional knowledge about these plants, already demonstrated in the scientific article by Oliveira e Sousa (2020) where 39 botanical families and 68 species of medicinal plants were diagnosed, it is expected that the Medicinal and Aromatic Forests can give volume to the production of certain species of interest to the pharmacological and cosmetic industry, thus increasing the income of indigenous families and the promotion of a Bioeconomy that is still latent for traditional

peoples in the Amazon. It is necessary to make the productive inclusion of indigenous populations in fair markets, which is only possible if there are modern models of production such as the proposed Medicinal & Aromatic Forests, whose main functions are the economic sustainability of extractive populations, empowerment of indigenous families over the production chain of medicinal and aromatic plants and the protagonist of these peoples ahead of the new productive spaces created.

As for the structure of these Medicinal & Aromatic Forests will be planted in blocks, where in each block will be the 14 species distributed in the ranges of plantations composed of three lines as well as between lines, as shown in Figure 3.

Figure 3- Theoretical model of Medicinal and Aromatic Forests with planting ranges composed of 3 lines of trees interspersed with two types of herbaceous species*. Espécie 1=*Carapa guianensis*; Espécie 2= *Protium heptaphyllum; Espécie 3= Dipteryx odorata;* Espécie 4=*Nectandra sp.; Espécie 5= Aniba canelilla; Espécie 6= Handroanthus impetiginosus;* Espécie 7= *Cymbopogon citratus*; Espécie 8= *Plectranthus amboinicus.*



One of the species, the thick leaf *or Plectranthus amboinicus* draws our attention for being the species with the highest Value of Use by the indigenous peoples of the Munduruku ethnic group in the Ipaupixuna Village, being indicated for Cough, asthma, clean the eyes, flu, inflammation, red and injury. These results are proven by studies by Pavla et al (2009) whose results suggest that the hydroalcoholic extract of *P. amboinicus* possesses anti-inflammatory and antitumor activities, supporting the folk use of this medicinal specie. Therefore, increasing the stock of this species by planting them in systems such as medicinal forests for purposes for the herbal industry can be an alternative to the sustainability of traditional peoples in the Amazon.

According to Shubha & Bhatt (2015), *Plectranthus amboinicus* leaves also stimulate growth of probiotic L. *plantarum, thus* contributing to the softening of diarrhea, a disease quite common in children living forest environments. In accordance with the authors the hot water extract of *P. amboinicus* leaves inhibited growth of pathogens (*Escherichia coli and Salmonella typhimurium*) while stimulated the growth of L. plantarum.

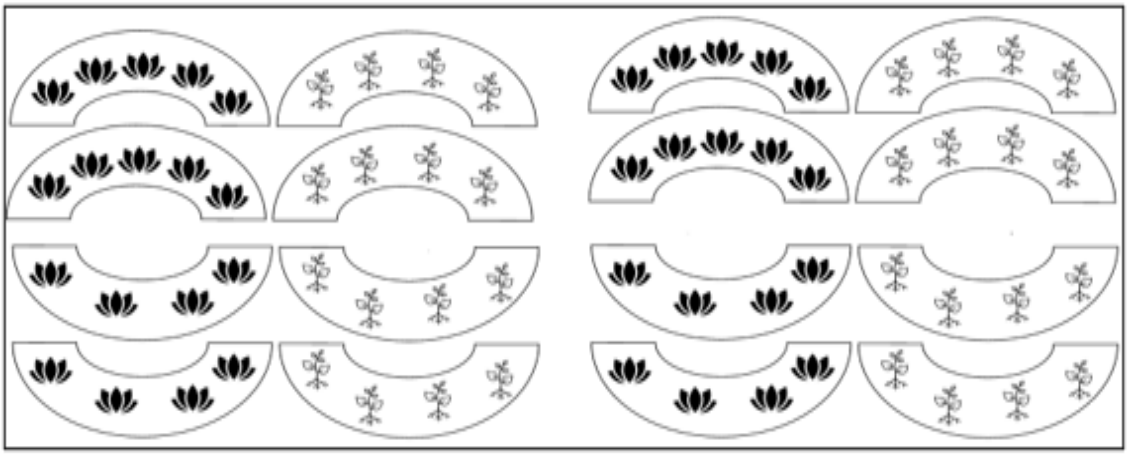
The multiplicity of medicinal uses of the genus *Plectranthus* can be observed in the work of Lambrechts & Lall (2020) who verifying the traditional usage and biological activity of *Plectranthus madagascariensis* and its varieties. The authors observed that extract and essential oil have polyphenols, abietane diterpenes and abietane diterpenes with a quinone moiety as constituents and it used for antibacterial activity against tuberculosis and wound infections and has been consistent and correlates with its documented traditional usage of the plant. In accordance with the authors, monoterpenoids, sesquiterpenoids, diterpenoids and phenolics have been reported in species of *Plectranthus.* The abietane diterpenoids are the most diverse of the diterpenoids isolated from species of *Plectranthus.* Thus, we have here a species to be commercially exploited in indigenous niches.

In addition to increasing the stock of medicinal species of interest in these models of Medicinal and Aromatic Forests, they still provide an ecosystem service, such as maintaining the diversity of microorganisms in soils, making it the healthiest. According to Melo (2020), who compared to forest and pasture areas in the Amazon, he found that the forest area presented the greatest bacterial diversities and species richness in relation to pasture.

3.2.2 Ethnogardens: are theoretical models corresponding to collective planting spaces in a collective area in the Village focused on the cultivation only of herbaceous medicinal *plants*, where technologies such as *mulching* and irrigation systems will be included, thus innovating in indigenous niches, but maintaining the species and traditional knowledge associated with them. We then have a hybrid model, where traditional knowledge and technological innovation go hand in hand. Such spaces are also spaces of resistance of traditional populations threatened in their territories because they explain the time, they are in these landscapes through the ancient knowledge they have about medicinal plants. However, this space will have an important function, that of semi-intensive production.

Unlike the backyards that each family cares for, where they produce their medicinal plants only for their own use and exchange with the other members of the village, the collective Ethnogardens are income generation spaces from the production chain of medicinal and aromatic plants, whose international market has high demand. However, this high demand is solved through a market that is not fair to these traditional populations, that *is, most industries buy raw materials in natura at exceptionally low* prices and without benefit between company/industry and traditional peoples. Breaking this *capitalist* habit in the economic relationship between these social groups is possible and with gain for all. The time has come for congruence in the discourse practiced by those who really defend traditional peoples in the Amazon, because, to fulfill, for example, the Sustainable Development Goals (SDGs), it is also necessary to try to correct or mitigate the inequalities of unfair markets in the Amazon such as those commented here. Thus, Ethnogardens emerge as a structure in semicircles with planting of herbaceous and shrub species, both hardwood and tubers or roots. These species were cited as high Value of Use by indigenous families in Ipaupixuna Village (Oliveira e Sousa, 2020), as shown in Figure 4.

Figure 4- Theoretical model of Ethnogardens in semicircles, with species interspersed between them for Ipaupixuna Village, Santarém, Pará, Brazil. Species were:1. *Jatropha gossypiifolia*.; 2. *Justicia acuminatissima; 3. Jatropha gossypiifolia;4. Jatropha curcas; 5. Uncaria tomentosa*; 6. *Allium sativum*; 7. *Fredericia chica; 8. Eleutherine plicata.*



3.3 MODELS OF IMPROVEMENT OF BIODIVERSITY RESOURCES AIMED AT THE TECHNOLOGICAL *INCREASE OF PLANT EXTRACTIVISM (TECHEXTRACTIVISM)* IN IPAUPIXUNA VILLAGE.

3.3.1 *Forest* Botika: a beneficiary pole of aromatic and herbal oils. The proposition of a space, here called Botika, for the processing of aromatic and herbal oils produced in medicinal forests or ethnogardens in the indigenous Territory itself causes this natural resource to add value when manipulated, thus increasing the income of indigenous families, since such product to be sold will now gain a higher price than before, gradually forcing the expansion of fair markets in the Amazon, specifically in the Tapajós River Basin. In addition to this aspect, there is the empowerment of groups of indigenous women that can be trained in workshops aimed at artisanal soap, oils and hydrolats among others in this Botika, making this space an important niche for indigenous women's belonging and empowerment. This Botika represents, therefore, the second link in the production chain of medicinal and aromatic plants, that is, the link of processing, while the first link, that of production, was represented by the medicinal and aromatic forests themselves. However, it is the third link in this production chain that may or may not make indigenous economic activity sustainable, that is, the link in transportation and marketing. Partnerships with companies and industries in the cosmetics, herbal and aromatic sectors should be the best strategies against the backdrop of fair *trade*. However, public policies can boost or hinder these negotiations based on the market logic chosen to support decision-making.

3.3.2 *Forest* Botika II: plant processing pole of teas, powders and flours of forest plants. This theoretical space model called Forest Botika II corresponds to a root, bark, leaf and tuber processing pole of plants diagnosed in ethnobotany analysis in products such as teas, powders and flours. Like Botika OF Oils, this Botika also has the primary function of adding value to the fresh product collected by extractivism in the forest, thus strengthening the link of processing in the production chain of medicinal plants and tubers. The products to be generated are of value to the nutraceutical industries, however, still little explored in a sustainable way under the fairtrade *scenario*. It can also be a space for empowering indigenous youth, thus being qualified in this activity, given that most of them have no income of their own.

3.3.3 *Botika of Honey:* beneficiary unit of honey.

Botika of Honey, in turn, as a theoretical model proposed in indigenous *niches*, has the function of stimulating meliponiculture (stingless bees of the genus *Melipona)* and the processing of its products, such as honey, pollen and flowering propolis that only have in the Amazon, this being the differential. Thus, the honey produced in indigenous territories gains value when one really wants to promote the sustainable development of traditional populations such as those of the Munduruku ethnic group, as well as, the plants gain, which has its pollination process guaranteed by bees in spaces such as medicinal forests and Ethnogardens. However, a second function of this Botika is, once again, to empower indigenous women from the empowerment of these in actions within the production chain of stingless bee honey, which invariably improves the collective income of the family.

Finally, to seek international partners interested in the Amazon to keep the forest standing through actions to encourage, finance and purchase of these by-products of the honey chain, as well as the chain of medicinal and aromatic plants, is to ensure the environmental, social and economic sustainability of indigenous peoples, either through strategies to purchase carbon credits or others.

4 CONCLUSIONS

We conclude that in Ipaupixuna Village, the production chain of medicinal, aromatic, fruit and honey plants are potential chains to be worked in *indigenous niches* but with technology, solidarity and respect for the millenary culture of Munduruku peoples, being possible the intertwining between traditional knowledge and new technological in the Amazon biome, Tapajós River Basin. Thus, *in situ* and *on farm* Conservation Centers are proposed and necessary new production spaces in indigenous territories threatened by deforestation, expansion of monocultures, livestock or mining, to mitigate the genetic erosion of plant species that already occurs *in* these areas, as well as maintain the floristic richness of plants of high Use Value to indigenous families, thus ensuring their socioeconomic sustainability. However, it is the Medicinal Forests and the Ethnogardens, the spaces of empowerment and belonging of this Village in front of the current market. From these models in the productive phase, these indigenous peoples may

have the support for the increase of the Bioeconomy in the phototherapeutic and cosmetologically sector, being protagonists of their own development.

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