

Food gardens in a Guarani Kaiowá indigenous community: a contribution to thinking ahead

Reflexões sobre os quintais produtivos em uma comunidade indígena Guarani Kaiowá: contribuições para pensar à frente

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Abstract: The aim of this study is to contribute to the characterization of the traditional food gardens and livelihood in Guarani Kaiowá peoples and discuss implications for extension services and development projects. The study was carried out in the Panambizinho indigenous territory, Mato Grosso do Sul, Brazil. Eleven families in the indigenous community (IC) were visited over one year. Particular characteristics, needs and management of the food gardens are revealed. The discussion covers several topics identified through the field visits, including specificities and pressures faced by ICs in Brazil. Keeping and prospecting for agroecological systems seems a positive strategy because this does not substantially interfere with or change their current way of life. Therefore, agroecological systems are a pathway to sustainable production, food security, health and quality of life in ICs. Implications for extension services and development projects are discussed while contextualizing economic, political and social challenges.

Keywords: Agroecology, Indigenous enterprise. Ethnodevelopment.

Resumo: Objetivou-se explorar e contribuir na caracterização de sistemas de produção de alimentos dos povos Guarani Kaiowá e discutir implicações para serviços de extensão rural e projetos de desenvolvimento. O estudo foi realizado na terra indígena Panambizinho, Mato Grosso do Sul, Brasil. Onze

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famílias da comunidade indígena foram visitadas durante um período de um ano. Características particulares, demandas e a gestão dos sistemas de produção tradicionais (*kokue*) são reveladas. A discussão abrange temas identificados durante as visitas *in loco*, incluindo especificidades e pressões enfrentadas pelas comunidades indígenas no Brasil. A manutenção e prospecção de sistemas agroecológicos parecem favoráveis porque não interferem substancialmente com o modo de vida atual. Assim, os sistemas agroecológicos são um caminho para a produção sustentável, segurança alimentar, saúde e qualidade de vida na comunidade. As implicações para os serviços de extensão e projetos de desenvolvimento são discutidas ao mesmo tempo em que desafios econômicos, políticos e sociais são contextualizados.

Palavras-chave: Agroecologia. Empreendimento indígena. Etnodesenvolvimento.

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Introduction

The history of Guarani Kaiowá peoples is marked by violence, land disputes, corruption and exploitation of land with conflicting interests between indigenous and non-indigenous peoples (FERREIRA, 2007; MOTA; PEREIRA, 2012; IORIS, 2019).

The demarcation of land by the Brazilian government started between 1905 and 1915, together with the establishment of indigenous reserves in 1917, supported by the emergence of the SPI - Indian Protection System in 1910 (defunct in 1967 after the foundation of FUNAI - the National Indian Foundation) (FERREIRA, 2007). Between 1915 and 1928, eight reserves were created in the State of Mato Grosso do Sul, allocating Guarani Kaiowá peoples and others.

The arranged settlements prompted miscegenation among ethnic groups, which also interfered with and weakened indigenous culture. From the early colonization of the backlands to recent times, the lack of opportunities for accessing food and income has systematically pressured indigenous people towards urban areas, forcing them to seek a living in construction companies, farms and industries (FERRANTE; FEARNSSIDE, 2020). Therefore, fair opportunities have become the reality for only a few indigenous peoples (FERREIRA, 2007; PEREIRA, 2003; NETO, 2019; BEGOTTI; PERES, 2019).

At present, there are over 800,000 indigenous people in Brazil from 305 groups living in 5366 villages. According to data from the Brazilian Institute of Geography and Statistics (IBGE, 2011), the State of Mato Grosso do Sul has the second largest indigenous population in the country, after the State of Amazonas. In Mato Grosso do Sul, there are approximately 85,000 individuals residing in reserves, communities, and camps belonging mainly to the Gaurani Nãndeva, Guarani Kaiowá and Terena ethnic groups. In recent years, the indigenous population in Mato Grosso do Sul increased from 6758 in 1998 to 15023 in 2014. However, availability of land decreased from 3600 hectares in 1917 to 3475 hectares (NETO, 2019). Currently, among the 4000 indigenous families living in the Indigenous Reserve of Dourados (RID) in Mato Grosso do Sul, around 50%

live in inappropriate housing conditions, in dwellings built from plastic tarps, cardboard and paper, etc. (NETO, 2019).

The State of Mato Grosso do Sul is one of the largest grain producers in the country (mainly soya and maize). The region is marked by the expansion of export-oriented agricultural intensification, which relies on the use of chemical fertilizers, pesticides and monoculture systems. This contrasts with the indigenous way of life and principles of agroecology (POSEY, 1985; SCHULZ; BECKER; GÖTSCH, 1994; PINHO et al., 2011; ALTIERI; FUNES-MONZOTE, 2012; SALIM et al., 2018).

There is little information about the impact of pesticide exposure on human health in the ICs (POLIDORO et al., 2008). Still, the hazards and risks related to the usage of pesticides (ROCHA et al., 2018) are aggravated by the condition that ICs typically lack culturally appropriate farming education and certification programs. This includes safe handling practices, infrastructure and suitable agrochemical storage, transport and waste disposal facilities (POLIDORO et al., 2008). Overall, severe interference from agricultural development associated with the lives and livelihood of indigenous peoples have been extensively reported (RIBEIRO; NETO, 2019; GONÇALVES et al., 2012; GRAY, BOZIGAR, BILSBORROW, 2015).

There are several reports about severe food shortage and nutritional insecurity of people living in the demarcated areas, associated with a drastic reduction of biological diversity, losses of genetic resources and productive disruptions (NETO, 2019; BEGOTTI; PERES, 2019).

Systematically, anthropogenic pressures and several other features have weakened the social organization of indigenous villages and their way of life. Moreover, these pressures have shifted indigenous peoples from their lands, which were further taken over by ranchers, with great impact on indigenous practices such as planting, hunting and fishing (FERREIRA, 2007; PEREIRA, 2003; NETO, 2019).

As a result, what remains for many Guarani Kaiowá peoples are memories of their traditional territories (*tekoha*). Even if outnumbered, with uneven opportunities, and facing many hazards, many indigenous people in Mato Grosso do Sul stand firm and restore traditional practices and lifestyles, including the adoption of food production to enhance their livelihood (BEGOTTI & PERES, 2019; PEREIRA, 1995; FERREIRA, MATSUO, SOUSA, 2011).

Strengthening indigenous autonomy, food security and well-being is challenging. It requires public actions and agricultural innovation policy instruments that contribute to innovative systems and dynamics (HERMANS et al., 2019). However, the effectiveness of these actions and partnerships is likely to depend on the participation of indigenous peoples in the planning, execution and evaluation of actions. In this sense, food production in indigenous land should account for the socio-cultural standards of those involved. Investments should be made thinking ahead to sustainable development alternatives that may favor the resilience of ICs, wherever they may live and whatever they may produce. This evokes a systemic approach referred to as ethnodevelopment and community-based appraisals.

Despite several interests related to development in indigenous communities (ICs), research in the field of indigenous food systems is limited. The characteristics and general needs in indigenous food systems, and the role they play in the contemporary indigenous way of life is underreported (MARKHAM; KERINS, 2020; POWER, 2008; SKINNER; HANNING, 2013). It is assumed that the assessment of food systems in ICs is necessary to align sustainable initiatives and nurture innovation systems, which are subject to extension services and rural advisory systems. The applicability of this may support those committed to tackling vulnerability of ICs and prompting indigenous foodscapes.

The lack of research on indigenous food systems limits extension services and development projects due to uncertainty about what to do in response to hunger, poverty, healthcare and other needs (COELHO; SHANKLAND, 2011; POLLARD, 2012), including rural advisory services. Therefore, studies in this field are of great interest, as they can contribute to the development of ICs.

This study aims to explore and characterize traditional food gardens and livelihood in Guarani Kaiowá peoples and discuss the implications for extension services and development projects. By examining indigenous ways of producing food, including specificities and needs, we believe that extension services and advisory systems can use findings to validate or even rethink the pathways for food security, sustainable food production and alternative agri-food systems in ICs.

The paper is organized in sections. First, some indigenous values and organizational specificities, including pressures faced by ICs, are put into perspective. This includes some schooling and socio-demographic characteristics of Brazilian ICs, the situation of public extension institutes and rural development policies. Further, the study area, data collection and analysis are described and the paper reveals characteristics of the food gardens accessed. This encompasses the genetic resources, management of the food gardens, agricultural entrepreneurship and aspects related to religion. Based on the results, practical implications and lessons for extension services and development projects are presented.

Facing a diverse socio-political, cultural and economic context

The preservation of cultural, social and agricultural diversity is among the sociopolitical and developmental challenges faced in ICs (BEGOTTI; PERES, 2019). For example, the level of organization among ICs varies considerably (ROGERS et al., 2018; SIRISAI et al., 2013), and cooperation between indigenous families may not be part of their customs. This shows the importance of understanding and fulfilling the specificities of different ICs.

In fact, indigenous values and non-indigenous practices and cultures can be contrasting. According to Diegues et al (2000, p. 18), societies have developed particular ways of managing natural resources which are not always aimed directly to profit, but to cultural and social reproduction, or to perceptions and representations related to the natural world. Thus, endeavors can be multi-faceted, based on multi-sector food-interest groups, to cooperate and support food security, and balance cultural and economic notions of value (BRIMBLECOMBE et al., 2014; KAWHARU, 2019).

Some projects developed in Brazilian ICs have revealed some historical, mythical and prophetic aspects, which reflect cultural and ethnic identities of Guarani and other indigenous peoples (CAMPOS; GODOY; SILVA, 2018). Potentially, this could generate ideas on how to encourage and support indigenous agricultural production (FUNAI, 2020b; KUJAWA; TONET, 2017).

However, it is challenging to support and enhance agroecological production systems in Brazilian ICs due to difficulties ranging from the logistics of visits in loco to the establishment of partnerships with extension agencies. The Ministry of Agrarian Development (MDA) was dismantled by the federal government in 2016. In 2019, the closure of the Secretariat for Family Farming in Brazil represented a rupture in the more recent attempts to strengthen family-based agriculture in the country. Notably, Funai has a limited budget and faces a series of infrastructure and operational challenges, which have worsened over the past few years.

Public funding for extension and research has decreased in several regions of the world (GAFFNEY et al., 2019). In Brazil, government institutions for agricultural extension and research, and public policies for rural development, have been weakened (DIESEL et al., 2021; GRISA & NIERDELE, 2021).

In the context of the fragility and weakness of the public state, and the need to resist the crisis in the government extension services (ABDON & RAAB, 2005), partnerships between public and private sectors are alternative ways to think ahead. Likewise, integration of rural extension and agricultural research (ÁLVAREZ DE FERNÁNDEZ et al., 2006; SANTOS, 2001) may be strategic. Overall, the situation evokes social and institutional innovations, hybrid governance mechanisms, oriented to sustainability, empowerment of traditional communities and livelihood, and innovative systems in agriculture (EUROPEAN COMMISSION, 2013; HERMANS et al., 2019; UNECE, 2020).

Social rights in Brazil are not restricted to the population said to be white, but also apply to indigenous people (NOVAIS et al., 2013). Moreover, while poverty rates have declined over the last 15 years in Brazil, extreme poverty rates remain high among ICs (IBGE, 2011; BASTOS et al., 2017; BRASIL, 2019).

In respect to schooling in Brazil, indigenous student inclusion programs have been the subject of social research, i.e., quotas for indigenous peoples in the Federal University of Mato Grosso do Sul (NOVAIS et al., 2013). Scholars advocate that the system of quotas in Brazil needs to be continued in order to reduce inequalities and marginalization, to expand the participation in university access, and achieve full citizenship, welfare assistance and academic support given to the indigenous students (NOVAIS et al., 2013). Some international cooperation among universities, institutions and foundations has supported tutelary and contractual perspectives, with knowledge exchange (HOFFMANN, 2009).

In Mato Grosso do Sul, indigenous teachers from the Guarani, Kaiowá and Terena peoples have reported that the construction of students' identity was unsuccessful, with failures in the field of reading and writing (SOUZA; BRUNO, 2017). In an IC from the Terena people the schooling time averaged 3.8 years (16.3% of the indigenous women reported never having attended school) (FÁVARO et al., 2007). Since reading and writing are essential elements for the survival of many indigenous peoples (FRAGOSO, 2017), illiteracy (according to the standards established by the non-indigenous school) prevents individuals from properly developing and carrying on the expected progress in their community (SOUZA; BRUNO, 2017). Educational failure likely affects the capability of ICs to establish responses to emerging challenges and to develop formal market initiatives. Typically, entrepreneurship and innovation in the agri-food systems depend on new ideas, strategies, market links and partnerships with value chain actors.

Material and Methods

Characterization of the study area

The study took place in the Panambizinho indigenous territory, located in the southern portion of the state of Mato Grosso do Sul, Brazil, inserted in the indigenous territory of the municipality of Dourados, 25km from the city center. The Panambizinho indigenous territory comprises an area of approximately 15 km² in the district of Panambi. It is bordered to the east by the left bank of the Laranja Doce stream, a tributary of the Brilhante River. To the west it is limited by an imaginary line parallel to the MS 379 highway, which is approximately 400 meters

from the indigenous territory; to the north by a path called Travessão do Reginaldo; and to the south by the Hum stream, a tributary of the Laranja Doce stream (FUNAI, 2003). The Indigenous Territory has an area of 1,272.8035 hectares, corresponding to approximately 0.31% of the total area of the municipality of Dourados. Borders have the following coordinates: to the north -22°06'51"S, -54°41'27"W and -22°06'38"S, -54°39'01"W; to the east, -22°8'16"S, -54°39'20"W; to the south -22°08'38"S, -54°41'15"W; and to the west: -22°07'54"S, -54°41'19"W and -22°7'55"S, -54°41'21"W.

The indigenous land is located in the hydrographic basin of the Paraná River (SIMIELLI, 2008). Typically, Panambizinho is home to one ethnic group, the Guarani and Kaiowá community, which are part of the Guarani people, more specifically of the Guarani Ñandeva and Guarani Kaiowá groups. Thus, Panambizinho community or Panambizinho indigenous land are the specific terms for the location where the research was developed. Currently, there are around 516 people in Panambizinho (a little more than 116 families).

Besides its proximity to the largest university campus (in a range of 250km), the Panambizinho indigenous land was selected for research because it is formally established indigenous land, based on subsistence agriculture. This land is recognized as occupied by traditional indigenous peoples under the terms of § 1st art. 231 of the Brazilian Constitution of 1988. Regularization (formal establishment) is currently a prerequisite for ICs to receive actions of public policy and even the donation of basic food supplies. Even if civil actions can provide some support for ICs, the lack of regularization compromises actions to increase food security and to promote agroecological production through public actions mediated by agricultural extension services.

Moreover, the Midwest of Brazil ranks third in numbers of indigenous people in the country (56% of indigenous people in the Midwest of Brazil live in the State of Mato Grosso do Sul (FUNAI, 2020a). In numbers, the Guarani Kaiowá community from the State of Mato Grosso do Sul are the second biggest in Brazil, after the Tikuna peoples in the State of Amazonas (FUNAI, 2020a).

Data collection and analysis

The protocol for data collection included verbal and formal agreement with the chief (Cacique) of the indigenous village Panambizinho. The chief agreed and signed a formal consent form (January 2019) allowing data collection. After verbal consent from each individual family, free and informed consent forms (printed sheets) were handed out and signed by family members. The consent letter is based on Convention 169/ILO which provides for community consent for matters that affect the collectivity. Each indigenous people, indigenous land, or village, establishes its own criteria for granting consent. There is no written norm with national coverage explaining and guiding the process of granting and obtaining consent. In the case of Panambizinho, the chief stated that his signature was sufficient to authorize the collection of information, and that each household could decide whether or not to sign a consent letter. Other types of data used in the research are publicly accessible. Moreover, the research team takes part in the university (public) extension actions that support indigenous communities in the region. This exempted them from further applications to access the areas of study and the interviewees.

For the interviews in the field, a research script was developed by adapting multidisciplinary models of questionnaires used in research into agroforestry systems in Brazil. This covered a wide range of topics related to socio-cultural and economic values and challenges for advancements and community outcomes. The questionnaire was structured to obtain information about food

production and traditional practices, including motivations, responsibilities and way of life, besides the facilitating aspects and difficulties in conciliating technical and scientific information with traditional practices. Specifically, the following items were explored: usage, preference and requirement of fruits, trees, shrubs and medicinal species; monoculture, polyculture and consortium among species; conservationist or conventional management; identification of local knowledge or beliefs associated with food production; use, purpose or destination of food; adoption of synthetic fertilizers, organic or agroecological techniques; aptitudes, interests, and life experiences. Broadly, the questions intended to support the prospection of assertive collaboration towards improvement of quality of life, food security, and alternatives to promote income and tackle extreme poverty. Also, it was planned to bring evidence in order to guide extension services and funding that are expected to occur in the near future.

Data were collected in person (face to face) at the homes of eleven indigenous families living in the Panambizinho indigenous land. Convenience sampling was performed without restricting interviewees from adopting different techniques to produce food (qualitative or production scale aspects) and without restricting or excluding leaders of the indigenous community who exercise political or religious representations. The study also involved several informal discussions (unstructured dialogue) properly registered in field notes during the period of one year of field visits in the community. This enabled researchers to build familiarity among participants, forming connections and easier access, prior to the interviews.

Results and discussion

Characterization of Guarani Kaiowá food gardens (*kokue*)

Food production is practiced fully in the analyzed community. The indigenous people referred to their food gardens as *kokue*. The purpose of the *kokue* is not restricted to food production, but to provide environmental enrichment and well-being, among other aspects related to culture, religion, medicine and income.

Typically, agricultural management in the *kokue* occurs without adoption of agricultural machinery. Only one *kokue* (9.1%) presented an irrigation system.

The systems presented a high number of plant species and were characterized as chemical-free low-input systems. All *kokue* evaluated showed evidence of synergistic relationships among the cultivated species. The adopted techniques resembled syntropic farming and agroecology-based management systems. For example, in 91% of the *kokue* evaluated, some species were withdrawn from the system in order to allow the sunlight to fully reach smaller plants. In 82% of the *kokue*, spontaneous regeneration of plants was a well-established technique, widely adopted among the IC.

Because the interviewees did not use typical terminologies that specifically referred to agroecological production, we assumed that agroecological production is not a result of technical advisory services or governmental guidance, but local tradition. Still, we found that the adoption of several low-cost agroecological techniques is not currently present or properly appropriated by the Guarani and Kaiowá peoples.

Medicinal plants and flowers

Cultivation and usage of medicinal plant species was noticed in several families. They extract raw material found in intact forest fragments or open areas. It was observed that the production of medicinal herbs often related to rituals and the strengthening of traditional healing methods. This is performed by “prayers” (women and male) in Guarani communities, and by “*nheaderu* and *nhandesy*” in Kaiowá communities (CHAMORRO, 2015). It is known that medicinal plants are widely used to treat pathologies in the community but usually few families cultivate medicinal plants in Kaiowá and Guarani populations (BUENO et al., 2005). We found that this was done near the houses of the ones responsible for organizing and performing the rituals.

Flowers were cultivated in several locations of the IC for ornamental and entertainment purposes (as a hobby), besides religious beliefs and medicine. Among the Kaiowá and Guarani people, the beautiful, the good, and the healthy have the same meaning (“*porã*” in their native language). In this perspective, cultivating what is beautiful likely relates to improving well-being.

Genetic resources and food security

The interviewees showed great interest in adding new plant specimens to the *kokue* and shared concerns regarding food security and self-sufficiency in the IC. Specific demands related to acquisition of fruit trees and the need to plant trees around the *kokue* and around the IC. These could function as windbreaks (to preserve their tents) or wind buffers to reduce pesticide drift that comes from outside the IC. In most cases, the acquisition of plant genetic resources occurs through the exchange of seedlings and seeds between the Guarani Kaiowá people.

Erosion of locally adapted genetic material (plants and livestock) used by traditional communities has been reported, challenging food security, food sovereignty, culture and integrity of many communities (FAO, 2007; 2010). The locally adapted genetic resources are likely wearing away throughout generations, similar to traditional knowledge and practices in ICs (NOTTER, 1999; MARIANTE, EGITO, 2002; FAO, 2007; MARIANTE et al., 2009). Frequently, meat from hunting, fishing and forest-based food is decreasing as a result of socioeconomic and developmental changes, including influence from external economies and government policies (GRAY; BOZIGAR; BILSBORROW, 2015).

Still, there is some evidence of indigenous resistance to these transitions in Brazil. In these cases, ICs strategically manage biodiverse agricultural systems to allow forest regeneration, hunting, preservation of local traditions and direct contact with nature, in opposition to other types of agricultural systems (ROBERT et al., 2012; MACHADO, 2016).

Kokue management

Regarding the distribution of plant species in the *kokue*, in most of the gardens the arrangement of plants occurred at random, configuring a causal mixed distribution of plants. This finding contrasted with the agronomic techniques that are widespread throughout the conventional agricultural systems that surround the IC evaluated and that are predominant in Central Brazil. Only three *kokue* (27.2%) presented line planting of fruit and vegetables, and this was considered incipient.

With the exception of one indigenous individual who lived alone, management of *kokue* was always carried out by members of the same family (extended family). There was no observed

case in which indigenous people from different families cooperated in the management of a *kokue*. This finding contrasted with practical experiences of collective actions among indigenous peoples present in the Central-West Region of Brazil (i.e., Haliti, Nambikwara and Manoki (Copihanama) peoples) (FUNAI, 2020b).

The finding that management of the *kokue* is typically intra-family-based is a relevant and under-reported feature of the indigenous peoples evaluated. The intra-family way of managing the *kokue* may be a consequence of vulnerability, extreme poverty or degeneration of ICs. No doubt, reports about the socio-spatial trajectory of Guarani and Kaiowá groups are dramatic (IORIS, 2019).

Data from Funai suggest that the amount of land available and suitable for food production, and the layout of allotments, likely affects the collaborative initiatives among the Guarani-Kaiowá community members. In Panambizinho, some families live on six hectares of land, many live on one hectare, and the average is 2.46 ha per capita (<https://terrasindigenas.org.br>). Based on information from Funai, we observed that availability of land is scarce in all surrounding villages (i.e., 0.20 hectares per capita in Jaguapiru and Bororó villages), in the RID. Most estimations from Funai come from data regarding the total area, without discounting the public areas (i.e., schools, health centers, roads, quarries, springs, etc.).

Additionally, the lack of collective actions observed may relate to the low number of bovines. Extensive cattle ranching in small areas would require intensive rotational grazing systems, meaning that land sharing would be mandatory. Also, it was noticed that some leasing of indigenous land for monoculture production of soya and maize, which is currently illegal, pressures subsistence agriculture along with the availability of land for agricultural production in the IC assessed. This may also be a consequence of a lack of collective actions.

Agricultural entrepreneurship

Regarding the production in the *kokue*, there was no clear market orientation, no connection with regional value chains, and no networking attributes configuring indigenous entrepreneurs, rural competitiveness and formal market initiatives. Specifically, income from food production seemed vague or even absent. In a few cases, income from agricultural production was enough to pay the electricity bill, when electricity was accessible. All interviews were unanimous on stating that rural extension services were currently inattentive or even absent in the community.

There are reports of mechanized soya cultivation in the IC with the cooperation of governmental research institutes in Mato Grosso do Sul (KUJAWA; TONET, 2017). The reported initiatives prompted the distribution of non-transgenic seeds relying on yield and income generation for indigenous people. In Southern Brazil, indigenous people have benefited from planting soybean on their own land. In this case, the supply chain is structured and all grains serve as payment guarantees to suppliers of basic products, that is, for sustenance, education, health and to support planting in the area (KUJAWA; TONET, 2017). The aforementioned cases in Brazil suggest the existence of some incipient indigenous enterprises, that is, incipient (legal) business models that intend to link indigenous farmers to agricultural value chains. This discussion seems to be gaining force in the literature (LOGUE et al., 2017; KAWHARU, 2019). One missing piece seems to be the lack of integrative approaches that enable higher-level decision-making structures that could strengthen collaborative capacity of ICs in respect to food security and the development of indigenous food systems (ROGERS et al., 2018; BRIMBLECOMBE et al., 2017).

However, despite some efforts to include rural indigenous people in value chains this remains challenging. One must consider that many indigenous families and ICs do not aim to plant for income generation, as there is no need in their culture to generate and accumulate income. Moreover, even if economic development is about the advancement and growth of communities and the improvement of people's livelihoods (KAWHARU, 2019), the indigenous people are the tributaries of sustainable development, so integration of indigenous people to value chains alone does not necessarily configure development.

Aspects related to religion

Historically, the Guarani Kaiowá people are encouraged by leaders to sing and pray to “scare away the pests”. Many believe that plants are born from the body of their god, *Jakaira*, responsible for providing good production and food abundance. The *Jerosy* ritual, which involves singing, dancing, and praying for food, purifies food and makes it suitable for consumption. According to indigenous belief, *Jerosy* counts the time of creation of agricultural products. When sung by the *nhanderus* (religious leaders) and their helpers (*yvyra'ija*), time restarts, justifying the importance of performing the rituals. The hymn of *Jerosy*, a blessing (*jehovasa*) sung before consuming food, ensures that each food item receives the vital force required to satisfy people's needs. Veneration to *Jakaira* is based on the belief that it is the god himself, along with a brother, who ensures vital force for the plants to develop and become productive. This belief is a recurrent theme in the grey literature (i.e., booklets and discussion forums related to Guarani Kaiowá peoples) and was confirmed by around 70% of the interviewees.

In the IC evaluated, interviewees stated that some species must originate from natural regeneration alone. Thus, according to the grey literature, religion forbids planting some specimens, as some plants relate to the initial and final milestones of the human life cycle. Additionally, the production of some species close to homes is banned due to tradition and cultural precepts.

According to a female local preacher and religious leader (*nhandesy*), the Kaiowá peoples should not be encouraged to sell their food because, in the traditional belief, the outcomes are gifts from *Jakaira*, a guardian deity. In this sense, she affirmed that selling what Kaiowá people receive from the divinity is a sign of lack of solidarity. However, not all interviewees followed this precept or shared the same beliefs and wishes. This was considered evidence of heterogeneity in the community assessed, which encourages reflections about agricultural entrepreneurship and alternative food systems in ICs.

Lessons for extension services and development projects in the community assessed

Our findings suggest that the prospect of agricultural production on indigenous lands with techniques of intensive production is limited, as this type of agricultural practice is not part of their culture.

As an alternative to the diverse context of ICs and specificities of the IC, some authors have suggested the adoption of agroecological practices as a productive process allied to the traditional practices of these peoples, diversifying production for self-consumption and commercialization, ensuring income (NAIR, 1993; DUBOIS, 1996; GAZEL FILHO, 2008; CASTRO et al., 2009; PADOVAN et al., 2016; CAMARGO et al., 2019; MARTINELLI et al., 2019a; MARTINELLI et al., 2019b).

Essentially, agroecological systems relate to nutritional enrichment, production of goods and income supplementation in areas close to the homes of indigenous peoples. The maintenance of these systems can contribute to agrobiodiversity and preservation of nature. However, the adoption of low-cost innovation alternatives in the community will require Guarani Kaiowá indigenous people to form closer ties with local development agents, allowing discussion and reflection about traditional practices and non-indigenous technology alternatives.

Norder et al (2019) revised the activities carried out based on agroecology principles in indigenous lands from different regions of Brazil. The authors found that most initiatives sought to revalue indigenous identity, culture and traditions. Respecting the specificities of each group, the initiatives aimed to create sustainable and adapted productive systems, sustainable forest management and the formation of agroforestry systems. Mainly, this refers to the adoption of participatory and dialogic methods, aimed at empowering communities, reflection on gender relations, youth, the improvement of eating habits and environmental management, with reorientation in the fields of education and extension (NORDER et al., 2019).

In addition, the introduction of alternative vegetable varieties is a demand that needs fulfilling. Flower production could potentially relate to a market niche for indigenous people who live close to urban centers. Flowers are usually required for religious ceremonies (indigenous and non-indigenous) and events related to the Christian calendar that take place in nearby non-indigenous communities. Flowers attract pollinating insects, useful for biological pest control, also enabling production of honey, alternative medicine and seeds to feed people, birds, native animals and livestock.

Access to genetic resources should also be considered by the rural extension services, since it is key to ensure food security, food sovereignty and self-sufficiency. Additionally, trees, shrubs and other plant species may generate income for current and future generations of Guarani Kaiowá peoples.

In our study, with the exception of exchanging seedlings and seeds, the absence of cooperation between families in a single *kokue* is an indication that promoting collective actions (i.e., “agroforestry task forces”) among indigenous people would have limited effects. If proposed, collective actions would likely interfere or contrast with the local culture of Guarani Kaiowá peoples. This is a relevant finding for participatory community-based planning and collective food production among Guarani Kaiowá peoples and should serve as orientation for future rural extension services and field projects addressed to these indigenous peoples.

Typically, agro-ecosystems located in Brazilian indigenous land lack sophisticated irrigation systems (plastic pipes, sprinkler, drip hoses, electric pumps, etc.). Irrigation systems in traditional communities were discussed in the literature as early as 1977 (COWARD, 1977), revealing possibilities of applying construction, maintenance and administration strategies present in irrigation systems of indigenous communities in modern-like systems. This includes management of system repairs and form of compensation, as well as rewards for those in charge of water (i.e., larger plots of the harvest, larger amounts of land for planting and exemption from labor). It also highlights the possibility of replacing the materials at the sites, easier transportation and logistics, which contrast with the situation in which people depend on financial resources and the shipping of equipment not available in the communities.

The establishment of demonstrative units in ICs could bring advantages and opportunities for the indigenous people, and even change some beliefs that impair income generation. We emphasize the importance of indigenous experimenters, those who are less conservative in

regard to traditional behavior and adoption of innovations. These are key actors to disseminate techniques such as soil conservation management, seedling nurseries, spacing techniques, the usage of natural fertilizers and organic inputs that help to prevent pest infestation, planting of different species and other alternatives that do not interfere substantially in the indigenous beliefs and way of life.

Another feature is the presence of traditional masters in the entire process of implementing agroecological systems. Leaders are able to translate the advice of technicians so that traditional masters and young people can become key actors to value and enhance the usage of the traditional calendars, and the appropriate hymns and prayers for each stage of planting, moving through sowing, harvest and storage.

A potential pathway is to encourage articulation with school units in indigenous lands, as students could develop different activities in theoretical classes and hands-on activities, functioning as diffusers of innovation or developmental agents.

In practice, rural advisory teams must consider that in many indigenous societies the numerical systems are different, with no proper record of variables (SANTOS; PEREIRA, 2005). Typically, orality is a feature of indigenous cultures, with no strict construction and pre-existing knowledge schemes (FRAGOSO, 2017). Thus, one must consider that the indigenous education scene takes place in different spaces, generated among members of the community, with particular mechanisms for transmitting knowledge (OLIVEIRA; BRITO; KALHIL, 2017).

With respect to agroecological production and (non) usage of pesticides, long-term solutions are necessary, including the development of policies, infrastructure, markets and other alternatives that support non-chemical pest management (POLIDORO et al., 2008).

Strengthening the agroecological systems is possible by supporting diversified production of fruit plants, trees for shading, timber, firewood, ornamental species, plants that supply raw materials for handicrafts and household utensils, medicinal herbs, and sacred plants for rituals. Large plant species cultivated along the edge of roads can connect houses, providing community well-being. Roadside planting can enable the enrichment of local flora, subsidizing pollination and enhancing the local environment. Plants in surrounding regions of rural communities can act as “hedges”, preventing the wind from spreading pesticides further into households and areas of agroecological production (CARVALHO, 2013; LORENZI, 2009; SOUZA; LORENZI, 2012).

Moreover, the prospection of agroecological systems in ICs should encourage active knowledge sharing and participatory appraisals to deepen the description, situation and problematics of the food systems (ROGERS et al., 2018; ZUIN; ZUIN, 2008; MACHADO; HEGEDUS; SILVEIRA, 2006). Since the adoption of several low-cost agroecological techniques is not currently present or properly appropriated by the Guarani and Kaiowá peoples, it can be considered a bottleneck holding up their resistance and the increase in agroecological food production, to guarantee food security and food sovereignty in the IC.

Several reported initiatives have operated based on field days, on-farm demonstrations of restoration of degraded areas, hands-on management of agroforestry systems, seed exchange fairs, incentives for and protection of cultural expressions, etc. (NORDER et al., 2019; CAMPOS; GODOY; SILVA, 2018; QUEIROZ, 2013). Potentially, indigenous community members may benefit from these initiatives, by appropriating knowledge, strengthening local capacities and obtaining some advantage (PORTER, 1985), associated with fostering rural enterprises or enhancing food security and food sovereignty (MARKHAM; KERINS, 2020; ROGERS et al., 2018).

We advocate that priority should be given to the conciliation of indigenous and non-indigenous agroecological principles by development initiatives, mainly through the adoption of sustainable ecological and economic win-win situations (SANTOS-MARTÍN et al., 2019). This is in opposition to approaches that may abruptly switch or considerably neglect the traditional values and the way of life in the IC. Likewise, we defend that development initiatives should account for the heterogeneity of personal beliefs, expectations and life goals among indigenous people (from the same village or not). This may help to demystify preconceived opinions about ICs that likely hamper society and development agents from looking back and thinking ahead. For example, Comar et al (2019) argued that the reproduction of stereotypes that portrayed indigenous peoples in Brazil as bearers of customs considered to be primitive has led to harmful and ineffective policies for these populations and failures in the implementation of ethnodevelopment projects.

The aforementioned implications and perspectives should reach politicians, stakeholders, research and rural extension staff members and other personnel from public or private support organizations in order to support participative agroecological-based sustainable development in ICs.

Conclusions

The research conducted at the Panambizinho IC deepened our understanding of how Guarani Kaiowá households and individuals produce and access food in their indigenous land. The orientation of the discussion towards the current characteristics of the indigenous food systems was an attempt to prospect innovation with technologies and framework that seem more aligned to the ICs studied. This potentially sheds light on how rural extension should be encouraged and how it should operate.

Religion plays a prominent role in all spheres of social life for the Guarani peoples and some considerations are required regarding the supernatural-farmer-product relationships. Sacred cults and their meanings are crucial when discussing and proposing food production in the Guarani and Kaiowá indigenous lands. It is mandatory to care for the religious aspects and the wishes of the indigenous peoples, including the ways they choose to organize their community and life projects.

Agroecology is part of the lifestyle and the food production systems of the Guarani Kaiowá, Guarani Ñandeva, and Mbya peoples. The prospection of agroecological systems in Kaiowá and Guarani indigenous lands seems favorable, if traditional knowledge, religion and culture are accounted for. Overall, the IC evaluated here manages the food systems in a particular fashion and made specific demands to help sustain these systems.

These are guidelines to make extension services more ethical and to promote autonomy and self-sufficiency in ICs. The study reinforces that ethnodevelopment should be a theoretical and practical framework, in the short and long term, for initiatives aiming to prompt food production and food security in ICs.

We advocate that the current situation among Guarani Kaiowá peoples is opportune for the maintenance and encouragement of agroecological production, since agroecological practices do not substantially interfere with or change their way of life.

Initially, supporting agroecology within the community may expand the possibilities of sustainable production, food security, health and quality of life. Further, it may also be a starting point to encourage innovation systems and sustainable supply chain initiatives.

Integration of indigenous peoples into agricultural initiatives, designed to generate income and preserve indigenous culture, is a road to travel. The problem lies in the economic conditions and political circumstances. Budget cuts, the weakening of public institutions responsible for agricultural research and rural extension and the weakening of rural development policies will likely pressure ICs to lease their lands for monoculture production. This challenges development projects and extension services that address sustainable food production, food security, health and quality of life in Brazilian ICs.

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