

Farmers and Social Innovations in Rural Development: Collaborative Arrangements in Eastern Brazilian Amazon



Célia Futemma^{a,*}, Fábio De Castro^b, Eduardo S. Brondizio^c

^a State University of Campinas (UNICAMP), Center for Environmental Study and Research (NEPAM), Campinas, SP, Brazil

^b Centre for Latin American Research and Documentation (CEDLA), University of Amsterdam, Amsterdam, the Netherlands

^c The Department of Anthropology, Center for the Analysis of Social-Ecological Landscapes (CASEL), The Ostrom Workshop, Bloomington, Bloomington, IN, USA

ARTICLE INFO

Keywords:

Collaborative models
Agency
Sustainable Rural Development
Small-scale Farmers
Oil-palm
Agroforestry
Brazilian Amazon

ABSTRACT

Brazilian small-scale farmers are seeking new types of collaborations and economic opportunities amid a changing world. Market opportunities, however, have incurred demanding environmental, financial and labor requirements, and created trade-offs between expanding cash crops and maintaining livelihood security. We analyze the Tomé-Açu region in the Brazilian Amazon, where different collaborative models between small-scale farmers and other social agents (industries, government, non-governmental organizations) have emerged. Local farmers are engaging in collective actions and pursuing different types of partnerships, which facilitate knowledge exchange and access to market niches, also helping them overcome the infrastructural and logistical deficiencies that have historically limited rural development in the region. In particular, we discuss the diffusion and adoption of agroforestry and oil palm production systems among small-scale farmers. We examine the challenges and opportunities these partnerships and social innovations have created for local farmers, who are part of heterogeneous groups with distinct roles, assets and contexts. The state-led oil palm program posed challenges to small-scale farmers who experienced asymmetrical relationships within their partnership with private companies. On the other hand, the farmer-led agroforestry model opened new opportunities for farmers who had more flexibility in deciding their production arrangements, developing new agroforestry techniques, and pursuing commercialization pathways. Despite their limited power, small-scale farmers have been able to overcome some structural barriers through innovations, entrepreneurship, and renegotiation of oil palm contract farming. Thus, their ability to engage in both farmer-led agroforestry and state-led oil palm programs provides concrete examples of the potential of local governance based on collaborative arrangements to support sustainable farming production systems.

1. Introduction

Historically, small-scale farmers¹ in the Amazon region have been trapped in a vicious cycle of poverty and marginalization. Yet, the region has also been witnessing the emergence of an array of local social innovations confronting these issues. This paper addresses the emergence of multiple collaborative arrangements involving local farmers and other social agents (industries, government, non-governmental organizations) in Eastern Amazon. We pay particular attention to arrangements aimed at enhancing the production and commercialization

of agricultural products. Following an actor-oriented approach to rural development (Long, 2001), we argue that local farmers are actively developing new types of collaborative models with external actors and institutions. We conceptualize these collaborative arrangements as social innovations, which comprise creative grassroots solutions based on new social relations that can contribute to productive social-ecological transformations (van der Have and Rubalcaba, 2016). However, we contend that the outcome of such innovations cannot be assumed and must be critically analyzed in terms of their social and environmental outcomes.

* Corresponding author.

E-mail addresses: cfutemma@unicamp.br (C. Futemma), F.decastro@cedla.nl (F. De Castro), ebrondiz@indiana.edu (E.S. Brondizio).

¹ Small-scale farmers is a general term covering family farmers, smallholder farmers, local communities (traditional and Indigenous farmers), and rural settlements (settlers and landless farmers) (see Netting, 1993; Brondizio et al., 2009). Family farmers, according to Brazilian Law 11,326/2006, are small-scale producers who own land that is limited in size (varies according to Brazilian regions), where farming activities make up at least 70% of the work developed, which in turn depends on the labor of family members. "Traditional population" has become an umbrella category in Brazil encompassing different social groups whose cultural distinctiveness is expressed in terms of specific territorialities, such as Amerindians and Afro-Brazilian (see <http://www.icmbio.gov.br/portal/populacoestracionais>),

Rural development programs in the Amazon have been historically designed from the top down and are often plagued by budget constraints and limited implementation capacity (Gomes and Vergolino, 1997). The mismatch between national policy goals and local needs and capacity² – including low productivity, high commercialization costs, insufficient infrastructure, and technology –, recurrently lead to failure. In many cases, development projects lead to the erosion of social and human capital, and reinforced dependency on external aid. Amazonian small-scale farmers are recognized for their contributions to the development of productive farming systems, supplying food and commodities to regional and global markets (e.g., Brondizio, 2008). At the same time, Amazonian rural areas are characterized by high dependency on government aid, low literacy rate, low technical capacity and limited access to technology (Homma, 2015), limited access to markets, high transportation costs, and lack of access to public services (OECD, 2015; Callo-Concha and Denich, 2014) and structured violence against peasants (Sobreiro-Filho, 2019). These conditions have constrained local farmers to engage in and benefit from programs promoting sustainable rural development in the region. In fact, rural development initiatives have contributed, in some cases, to environmental degradation (Jos et al., 2016), vulnerability of agricultural systems (Homma, 2015), and frustrations and impoverishment resulted from project failures (Brondizio et al., 2009; Guedes et al., 2012).

Over the past decade, the implementation of more inclusive agrarian and environmental policies and programs have both opened up new opportunities and created new challenges for small-scale farmers (e.g., Sauer, 2019). On the one hand, credit programs have created new opportunities for enhancing agricultural production systems and access to markets; on the other hand, these programs also imply new labor standards and conservation practices and targets, which can be challenging for small-scale farmers to implement. Participating in such programs has required farmers to seek new forms of knowledge and gain experience regarding when, how and with whom to partner in order to benefit from and minimize risks associated with such opportunities. Engagement in collaborations with new external actors, such as private companies, NGOs and funders, is often characterized by asymmetric power relations, a steep learning curve, and frequent distrust.

This paper examines collaborative initiatives developed by small-scale farmers in the region of Tomé-Açu in Eastern Amazon, Brazil, particularly collective actions among small-scale farmers and partnerships between these farmers and other social actors. We analyze the diffusion and adoption of two farming systems – agroforestry and oil palm – under the lens of social innovation. Agroforestry systems involve collaboration between middle-scale farmers of Japanese descent and other small-scale farmers (most of them practicing shifting cultivation) in this region, with dissemination of agroforestry techniques from the former to the latter. Farmers of Japanese descent in Tomé-Açu are known for their successful combination of market-oriented agroforestry systems and a locally-based agro-industrial complex, which adds value to and promotes the export of the local agricultural production to national and global markets (Brondizio, 2012; Yamada and Gholz, 2002). Oil palm cultivation involves autonomous production and a policy-driven program established in 2010 to create incentives for small-scale farmers to engage in the local production chain of oil palm (Brandão et al., 2018).

The recent expansion of these two farming systems has triggered the emergence of new collaborative arrangements in the region. In this study, we analyze how these arrangements are shaping social and economic relations among and between farmers and other actors. We

assess whether these initiatives and partnerships are helping small-scale farmers to participate in and benefit from sustainable rural development and market opportunities or reproducing old structural barriers (or creating new ones).

2. COLLABORATION AS SOCIAL INNOVATION IN RURAL DEVELOPMENT

Innovative governance arrangements foster interactions and institutions that facilitate dialogue, knowledge building, and development of new practices. However, they often bring multiple social actors together under asymmetric relations, who negotiate their views, goals and interests in order to address collective challenges (Castro et al., 2016; Rhodes, 1996; Kooiman, 1993). In this study, we focus on collaborative arrangements involving farming systems adopted by local small-scale farmers as social innovation, which create new economic opportunities and help to overcome old structural barriers. Social innovations are likely to emerge among individuals bounded by strong social capital. Putnam (1993) defines social capital as resources comprising of three components – moral obligations and norms, social values, and social networks – which enhance group of individuals to coordinate and learn how to overcome social dilemmas. The author argues that previous experiences with active participation in social organizations contribute to individuals to engage in collaborative initiatives.

The distinction between bonding (e.g., intra-community ties) and bridging (e.g., inter-community ties) social capital helps to untangle level of interaction and organization from local to larger scales. The former tends to be associated with collaboration among individuals usually sharing more symmetrical social positions, such as members of a rural community, who collaborate to overcome common social dilemmas (Agrawal, 1996; Schlager and Blomquist, 1998; Varughese and Ostrom, 2001; Barnard, 2014). The latter tends to be associated with collaboration between two or more partners, who often have different values, resources and interests, and whose goals may not be similar, but are still compatible (Narrod et al., 2009; Park and Feiock, 2005).

Bonding and bridging social capital are expressed in forms of local collective action and partnership arrangements and are considered to have synergistic effects (Ostrom and Ahn 2003). Bonding social capital can support collective action among citizens to overcome external power struggles (Woolcock and Narayan, 2000), and institutional learning to build bridging social capital with other partners. Bridging social capital is particularly relevant to address broader challenges which require nested and multi-scale governance arrangements (Brondizio et al., 2009). In this regard, the State may play an important role as provider of resources and institutions that facilitate collaborations among different local organizations (Feiock, 2013; Park and Feiock, 2005).

Social capital, however, may lead to less desirable consequences of social cohesion, such as exclusion of outsiders, restrictions on individual freedom, and excess claims on group members (Porter 1998, pp. 15). Cartels, mafia and government corruption schemes and networks or organized land invasions in the Amazon are examples of how social capital can build cohesive groups in detriment of larger society welfare (Brondizio et al., 2009; Porter 1998). This critical perspective de-emphasizes the romanticization of communities (Levi, 1996, pp. 51), which tends to overlook power relations in collaborative arrangements (Levi, 1996; Brosius et al., 1998; Siisainem, 2000; Tzanakis, 2013). It calls for an understanding of mechanisms that normalize symbolic capital and struggles between cooperating parties under asymmetric relations.

Research and practice in rural development and conservation address a range of partnership types worldwide (Bodin, 2017; Koopmans et al., 2018; Wellbrock et al., 2013). In the Amazon, for example, particular attention has been given to company-community partnership (Morsello and Adger, 2007) and multi-stakeholders collaborations

² For example, improvements in infrastructure disregard seasonal patterns as well as the fact that the introduction of cash crops is often unsuitable to particular regions, and that technical assistance often disregards the local agricultural knowledge (Braga and Fudemma, 2015; Castro et al., 2005).

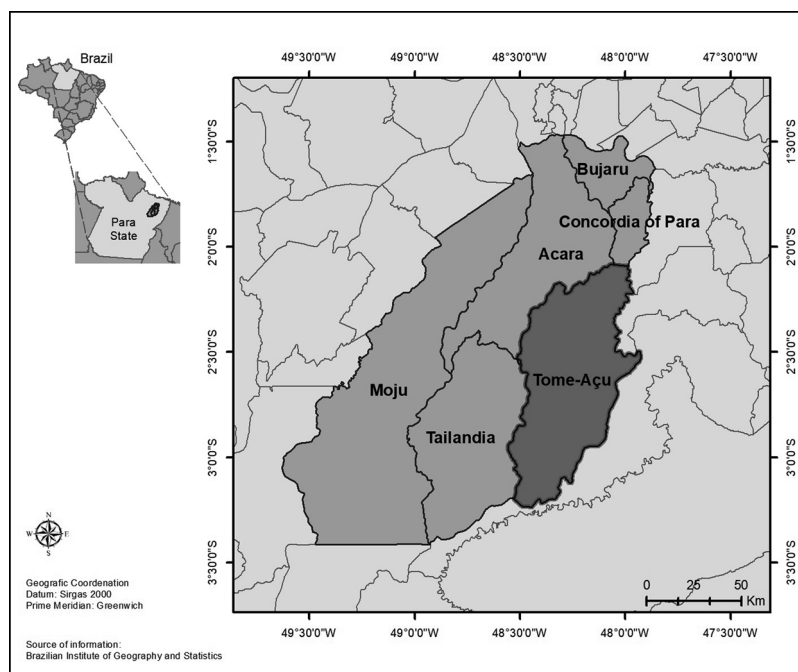


Fig. 1. Map of the Tomé-Açu micro-region (Pará, Brazil), Eastern Amazon (prepared by N.M. dos Santos, 2020).

(Sanchez et al., 2020). In addition, the Brazilian State has been highly influential in implementing social-environmental policies and procedures to promote bonding (collective action) and bridging (partnerships) social capital (Castro et al., 2014). Since the early 1990s, for instance, the federal credit program (FNO) for the Amazon has required farmers to form associations in order to access credit (Tura and Costa 2000). While there has been a significant reorientation of these policies in the last years (Toledo et al., 2017), these policies continue to have an effect on the region.

3. STUDY SITE AND METHODS

Tomé-Açu (TA) is located in Eastern Amazon, approximately 250 km south of the capital of the state of Pará, Belém (Fig. 1). It is a typical frontier municipality, characterized by limited infrastructure and low social indices. The region features a mosaic of different types of agriculture, cattle ranching, and logging. As a result, the rural landscape consists of dynamic patterns of land use and forest cover changes – including pasture, annual, perennial, and agroforestry fields with different sizes, and secondary and mature forests (Batistella et al., 2012; Callo-Concha and Denich, 2014). The rural population may be divided into three main groups – *Nikkei*³, *Colono* and traditional communities⁴. The former are descendants of Japanese immigrants who arrived in the region between the late 1920s and the 1950s. *Colonos* are descendants of rural migrants hailing from the Northeastern and Southern regions of Brazil, who settled in the region from the 1960s onwards (Callo-Concha and Denich, 2014). The traditional communities comprise a few Indigenous peoples and rural Afro-Brazilians, whose territories are managed collectively, and riverine communities including smallholders and sharecroppers.

The history of Tomé-Açu is intertwined with the unique saga of Japanese migrants, which is related to two successful farming cycles. The production of black pepper in mono-cultural systems (mid 1940s

and mid 1980s) placed the region among the top global producers of the crop (Bronzízio, 2012; Flohrschutz et al., 1983; Piekielek, 2010). After the crash of the black pepper economy, the local farmers started to experiment with different types of agroforestry systems, inspired by agroforestry techniques used in the region by riverine farmers. Over time, the community of Japanese descendants of Tomé-Açu became synonymous with what today is recognized as the Agroforestry System of Tomé-Açu, or SAFTA. SAFTA can take multiple forms and significantly vary in size, from less than one hectare to over one hundred. It usually involves one to three valuable cash crops, such as açai fruit (*Euterpe oleracea*), cocoa (*Theobroma cacao*), cupuaçu (*Theobroma grandiflorum*) and black pepper, a variety of tropical fruits, and production of oil, resin, and timber from different tree species. Considered suitable in terms of rainfall patterns and temperature, the region has also been seeing phases of expansion and retraction of oil palm cultivation (*Elaeis guineensis*). Originally introduced in the 1970s (Homma and Furlan, 2001), oil palm declined in the 1980s due to a pest outbreak. In 2010, its cultivation in the region has been revitalized through Brazil's Sustainable Oil Palm Production Program (SOPPP). Designed and launched by the federal government (Brandão et al., 2018), this program was based on two production models – large-scale agribusiness systems and small-scale contract farming systems (Brandão et al., 2018; Castro and Futeemma, 2014; Repórter Brasil, 2013) – the latter designed to be an inclusive rural development program for family farmers interested in entering the biodiesel production chain.

To understand how historical legacies and recent institutional changes have influenced rural development in the region, we focus on perceptions, interactions and practices associated with the diffusion of agroforestry techniques between medium-scale *Nikkei* farmers and small-scale farmers, herein referred to as *Colonos* (farmers who arrived in the region as government resettled or spontaneous colonists). Between 2011 and 2019, the two first authors carried out annual visits to this region lasting two to four weeks. Multiple visits have allowed us to keep in contact with local actors in different social contexts and build trust, which provided us the opportunity to interact closely with local collaborators and benefit from more reliable and sensitive information. Semi-structured interviews were carried out with 30 research participants from public universities, governmental agencies, grassroots

³ *Nikkei*: Japanese immigrants in Brazil, or descendants thereof.

⁴ Due to their collective territorial organization, traditional communities are not included in the analysis of this paper.

organizations, and palm oil companies in state capital Belém⁵ and in Tomé-Açu⁶. In addition, more than 40 rural properties were visited, where 20 agroforestry farmers, 14 oil-palm growers, and 5 technical assistants were interviewed. Several collaborators were interviewed multiple times. We avoided recording and chose to take written notes following free and prior informed consent. Finally, we participated in four locally organized annual Agroforestry seminars (2011, 2013, 2015, and 2018) to observe interactions, activities and the content discussed, and gathered secondary information on agricultural production and collaborative initiatives in public agencies.⁷

Next, we analyze a range of collaborative initiatives between small-scale farmers and between these farmers and other social actors.

4. BUILDING SOCIAL CAPITAL THROUGH COLLECTIVE ACTION

The history of resilience and prosperity of Japanese migrants and *Nikkei* descendants contrasts with the history of *Colono* farmers of persistent invisibility, inequality and exclusion (Brondízio, 2009; Nugent, 2009). In this session, we will show how these contrasting experiences of people living side-by-side in the region are influenced by different levels of external investment and development of human and social capital to support collective actions and help them adjust to a changing environment. We used a historical perspective to highlight the development of social capital and emergence of social innovations, as well as the relation between practices of collective actions and partnerships.

4.1. *Nikkei* Entrepreneurial Farmers

The first Japanese immigrants arrived in Tomé-Açu in the late 1920s (Fig. 2) as part of a rural settlement program (JAMIC). Each family received 20 hectares of land, which they gradually expanded, in some cases through land acquisition (Piekielek, 2010), up to 500 hectares. Some immigrants had higher education degrees (e.g., agricultural engineer), and most had agricultural training. Right from the start, these immigrant farmers and their descendants invested in education, building local schools and sending their children to study in other regions (e.g., state capital, Southern Brazil or Japan).

They were the protagonists of two agricultural transformations in the region: the rise of large-scale monoculture black pepper farming after WWII and, more recently, of the entrepreneurial agroforestry production system. The former represented their first wave of social mobility and institutional development, when they became one of the top three global black pepper suppliers for nearly five decades (Homma, 2004; Piekielek, 2010). The latter corresponds to the development and expansion of a diversified farming system based on multiple cash crops, comprising both annual and perennial species (Barros et al., 2009; Batistella et al., 2012; Yamada and Gholz, 2002), which earned them several prestigious national and international awards.⁸

⁵ Emilio Goeldi Pará Museum (MPEG), Federal University of Pará (UFPA), the Brazilian Agricultural Research Corporation (EMBRAPA) and the Brazilian Gas and Energy Company (Petrobrás), BBB, ITERPA.

⁶ Secretaries of Tomé-Açu (Agriculture; Environment; Education; and Social Welfare); The Mixed Farming Cooperative of Tomé-Açu; The Union of Rural Workers of Tomé-Açu, the Union of Family-Based Farmers and Rural Workers, and the Union of Workers of Tomé-Açu; the Bank of Amazonia (BASA) and the Bank of Brazil (BB); and the National Institute of Agrarian Reform (INCRA).

⁷ Brazilian Institute of Geography and Statistics (IBGE), Ministry of Agrarian Development (MDA), Institute for the Development of Pará (IDESP), and Secretariat of the Environment of Pará (SEMÁS).

⁸ E.g., International Cocoa Award – Cocoa of Excellence (Paris/France, 2010); Certificate of Appreciation – Japanese International Cooperation Agency (JICA, 2009); Agroforestry System and Social Inclusion Award (Bank of Brazil Foundation, 2013); Sustainable Entrepreneurship (Bank of Amazonia/FIEPA, 2012).

Grounded in refined empirical knowledge and entrepreneurial logics, their agroforestry system (locally referred to as SAFTA⁹) provides raw materials for the production of tropical fruit pulp and oils for national and international markets.¹⁰ Their intensive, diversified, and highly productive farming systems rely on hired rural workers who disseminate the knowledge on agroforestry techniques (see Session 5.1. Partnerships of *Nikkei* Farmers and Fig. 2). In order to reach the export market, they developed knowledge to deal with commercial regulations and technology to meet the international sanitary standards (Piekielek, 2010), signing contracts with private companies and donors and seeking support from researchers to carry out experiments (e.g., to enhance the productivity and diversification of their farming systems).

Agricultural innovations among *Nikkei* farmers are strongly rooted in collective actions, which have been part of their livelihood since the arrival of the first Japanese immigrants, addressing a range of social, infrastructural and agricultural issues. They have also benefited from the support of the Japanese government and organizations to improve the local infrastructure (Table 1).

Two local organizations are particularly relevant in the development of bonding social capital: the *Nikkei* Farming Cooperative and the *Nikkei* Cultural Association. The former plays a key role in their entrepreneurial identity and social organization. Created in 1931 as the Cooperative of Vegetables (CAMTA, 1967, Fig. 2), this organization has become successful and today comprises more than 160 members, 180 collaborators/employees, and more than 1,000 registered farmer suppliers.¹¹

The cooperative has recovered from recurrent challenges (Homma, 2004; Piekielek, 2010) by reshaping its organization, reconfiguring strategies, and generating new knowledge (Brondízio, 2012; Piekielek, 2010). Transferring leadership to younger members, searching for external financial support (e.g., Japanese aid programs), and investing in infrastructure and technology (e.g., fruit pulp processing plant), human resources (e.g., technical assistance and higher education) and social resources (e.g., shared knowledge and information, and trust built through reciprocity (Ostrom, 1990)) are some of the strategies adopted to overcome challenges (Brondízio, 2012; Piekielek, 2010).

Collective initiatives were inserted in the *Nikkei*'s social life, particularly through the *Nikkei* Cultural Association. Founded in the 1970s, this cultural association has nearly 200 members (Fig. 2). It offers several activities related to Japanese culture (Brondízio, 2012; Yamada, 1999), including sports (e.g., baseball and gateball), education (elementary and high schools), language (Japanese classes), and the organization of several traditional celebrations (Table 1).

The Cultural Association has been directly involved in the development of the SAFTA agroforestry system. The association is the main organizer of the Annual Agroforestry Symposium, an event created in 2010 to strengthen its partnership with external actors (Fig. 2). Each year, its members bring different groups of actors – *Colono* farmers, private companies, governmental agencies, financing agencies, universities, and non-profit organizations – to promote and seek support for their agroforestry system and products.

Collective actions in the *Nikkei* community involving their farming systems have been typically employed to address deficient or absent public goods (Table 1). For example, in the 1980s, they organized a community-based police patrol to tackle burglary and petty crimes targeting their properties (Brondízio, 2012), and in 1987, they created the Rural Electrical Cooperative of Tomé-Açu (COERTA) to address energy shortage (Piekielek, 2010) (Fig. 2). Such experiences have contributed to community building, institutional learning and

⁹ In Portuguese: *Sistema Agroflorestal de Tomé-Açu*.

¹⁰ For instance, the USA and Japan, especially açai fruit palm (*Euterpe oleracea*) and passion fruit (*Passiflora* sp.).

¹¹ Registered farmers are allowed to become Cooperative suppliers once they comply with the required quality standards.

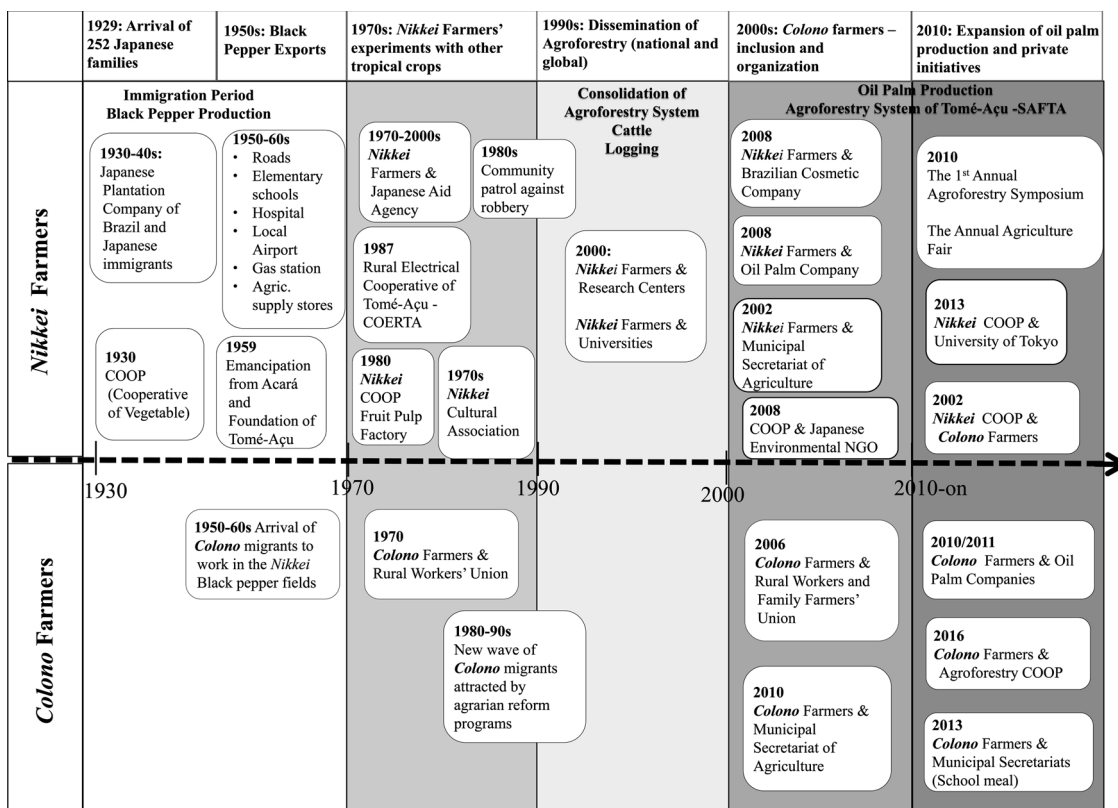


Fig. 2. Timeline – Joint Actions and Building Social Capital and Infrastructure. Source: Field data (2011-2019); Brondízio (2012); Piekielek (2010).

Table 1
Collective Action among Nikkei and Colono farmers in Tomé-Açu (PA, Brazil).

Group of Farmers	Type of Collective Action	Common Goal of Collective Action
Nikkei	Nikkei farming cooperative	Farming production chain (cultivation, fruit processing, market)
	Community police patrol	Public security
	Community road building	Infrastructure
	Community school building	Elementary education
	Community hospital building	Health care
	Community electricity generation	Energy supply
	Annual agroforestry seminars	Dissemination of SAFTA
Colono	Nikkei cultural association	Social, cultural and sport activities (seasonal and cultural festivities and sport events)
	Community celebrations	Social and cultural activities
	Soccer tournaments	Social and sport activities
	School festivities	Social and educational activities
	Community electricity generation	Energy supply
	Farming-related unions*	Institutional support to labor rights and social benefits
	Community-based cooperative (Group-based agroforestry)	Farming production chain (cultivation, fruit processing, market)

* Rural Workers' Union of Tomé-Açu; Rural Workers and Family Farmers' Union of Tomé-Açu, Workers' Union of Tomé-Açu.

infrastructure improvements needed to develop new initiatives, which culminated in the development of their own agroforestry system and the building of bridging social capital (Woolcock and Narayana, 2000).

As a result, Nikkei farmers have become a key player in the local politics and economy. They have attracted public funds for infrastructure development (e.g., local airport and hospitals) and occupied key positions in local government offices (e.g., mayor, secretary, school principals) and local businesses (Brondízio, 2012; Piekielek, 2010) (Table 1). In sum, the continuous effort to build human and physical capital and to develop farming innovation placed Nikkei farmers in a position of a local elite, and contributed to build bridging social capital in order to facilitate the development of new initiatives and new markets.

4.2. Colono Family-Based Farmers

Colono migrants arrived in Tomé-Açu during the 1950s and 1960s, attracted by the black pepper boom to work in Nikkei farms (Fig. 2). Initially, they occupied rural lots without holding land titles, the sizes of which ranged from 50 to 100 ha. This migration pattern continued throughout the 1980s and, in the 1990s, a new wave of migrant farmers arrived as formal beneficiaries of the government's agrarian reform programs, in settlements comprised of lots with 25–50 ha (Callo-Concha and Denich, 2014, pp. 42, Fig. 2).

These migrant farmers were similar to Colono families settled along highways and their feeder roads in other areas of the Amazon (Guedes et al., 2012; Barnard, 2014), often with low levels of formal education

(IDESP, 2014), whose farming system relied on family labor with minimum access to technology (Callo-Concha and Denich, 2014). Their production system, based on shifting cultivation, consisted mainly of annual crops such as manioc (*Manihot esculenta*), corn (*Zea mays*), and beans (*Phaseolus vulgaris*), complemented by other roots and fruit species, and in some cases a few heads of cattle. Despite the limited access to markets, they strived to maintain a balance between subsistence and commercial production, and continuously sought opportunities to improve their economic and social conditions.

In Tomé-Açu, many *Colono* farmers were influenced by the Japanese farming system, and the value Japanese farmers attach to self-confidence and independence. Many followed in the footsteps of *Nikkei* farmers and invested in commercial agroforestry systems, also adapting these systems to their traditional farming practices, whereas others engaged in seasonal off-farm jobs in oil palm fields, with direct impacts on their own family farming system.

In contrast to *Nikkei* farming families, the experiences of *Colono* farmers with collective action have historically taken place at the level of their rural village and/or at the regional level, through organizations such as rural workers' unions (Table 1). In villages located alongside roads, residents gather in collective areas (e.g., community center, school, soccer field or church) to participate in a range of activities and celebrations such as Patron saint days, regular soccer games and tournaments with teams from different villages¹², and school festivities (e.g., Indigenous Peoples' Day, Folklore Day, Mother's Day, Father's Day) (Table 1). At the level of villages, collective action initiatives among *Colono* farmers have focused mainly on social activities, political engagement, and solutions to factors constraining their farming system (Barnard, 2014). They are also involved with grassroots organizations such as the Rural Workers' Union of Tomé-Açu, which in turn represents local farmers and rural workers in regional and national forums.

Thus, the collective actions among *Colono* farmers are loosely connected to their farming practices and mainly related to political struggles, religious life and recreational practices (Table 1). These collective experiences contributed to enhance the bonding social capital (Woolcock and Narayan, 2000), which became the pillars upon which partnerships with other actors have been built.

5. SEEKING NEW OPPORTUNITIES THROUGH PARTNERSHIPS

While collective actions have been vital for both *Nikkei* and *Colono* farmers to address some bottlenecks in their farming system, broader collaborative efforts were needed to create new systems and seize new commercialization opportunities. In this section, we describe the partnerships built by both farmer categories, involving bilateral and multilateral arrangements between farmers and between them and external actors through bonds and bridges of social capital (Woolcock and Narayan, 2000).

5.1. Partnerships of *Nikkei* farmers

Nikkei farmers have built a successful network of partnerships with a large range of actors at multiple levels (Table 2). One important strategy used by them is occupying key positions in relevant organizations, such as the Rural Workers' Union, the Municipal Secretariat of Agriculture, the Municipal Government, and the Agribusiness Association of Acará Valley, the latter involved in cattle ranching¹³, through which they can promote institutional engagement in their flagship organizations (Cultural Association and Farming Cooperative).

Partnerships have been built at both the individual and collective

levels. At the individual level, farmers have collaborated with oil palm companies through formal contract farming¹⁴ (farmer-company partnership); with researchers, by allowing them to conduct experiments in their farms; and with government officials (farmer-researcher partnership), as well as policy makers (farmer-state partnership). In particular, they have been teaming up with research agencies such as EMBRAPA (Brazilian Agricultural Research Corporation) and CEPLAC (Brazilian Cocoa Research Center) since the 1990s, in various field experiments aimed at enhancing crop yield, combating diseases, and developing new plant recovery techniques (Table 2).

Collectively, *Nikkei* farmers have developed partnerships with a range of external actors through their agricultural cooperative to disseminate their commercial agroforestry system model, SAFTA, to *Colono* farmers and traditional populations in the region (see Section 5.3). The cooperative has also been engaged in a joint project with a Brazilian cosmetic company since 2008 to assess the viability of oil palm cultivation in its agroforestry system. This project, locally called SAF-dendê¹⁵, contrasts with the monoculture oil palm farming system promoted by the state in the region (Table 2). Along with the cooperative's technical assistance and logistic support, three cooperative members contributed with six hectares each for the experiments, while the cosmetic company and EMBRAPA provided financial and scientific support, respectively (Castellani et al., 2009, pp. 2) (Table 2). According to the cosmetic company's project coordinator, preliminary results indicate that the yield of oil palm cultivated in agroforestry systems is similar or higher than that of oil palm cultivated in monoculture systems (pers. communication, Aug/2018).

Partnerships, therefore, have been an important element in the diversification of the *Nikkei* farming system. They have fostered knowledge building and exchange (human capital), market expansion, and financial and institutional capacity, and led to the development of innovative farming systems such as SAFTA and SAF-dendê. In particular, the agriculture cooperative's collective organization has been a vital node in the network of partnerships formed by *Nikkei* farmers involving their innovations in the agroforestry system, thus being an important strategy for building both bonding and bridging social capital, as revealed in the words of a Japanese-Brazilian farmer and leader in Tomé-Açu, "if I don't know how to do something, I will try to partner up with someone who does".

5.2. Partnerships of *Colono* farmers

Similar to *Nikkei* farmers, *Colono* farmers have built partnerships both at the individual and collective levels based on bonding social capital. However, these arrangements address very different issues related to their farming production and concerns, such as access to employment, credit, and markets for agricultural products (Table 2). At the individual level, *Colono* farmers have engaged in contract farming to cultivate oil palm (farmer-company partnership). In contrast to the partnerships of *Nikkei* farmers with oil companies, which are built on more independent relations, *Colono* farmers are tied to a state-led incentive program aimed at promoting sustainable farming practices and rural development goals. The governance structure is pre-defined by the program based on highly restrictive contractual requirements regarding land use regulations (Abramovay and Magalhães, 2008).

In Tomé-Açu, approximately 200 *Colono* farmers engaged in this program between 2014 and 2018 (Fig. 2). The partnership arrangement includes the regional bank (BASA), two oil palm companies, and three Rural Unions (Brandão et al., 2018, Table 2). Farmers have to deal individually with each of these partners: with the bank, which provides

¹² There are more than 90 rural communities in Tomé-Açu (Union's Director, pers. communication).

¹³ In Portuguese: Associação Agropecuária do Vale do Acará.

¹⁴ The engagement of *Nikkei* farmers in oil palm cultivation started in the 1970s and is not related to the oil palm expansion program established in 2010 in the region.

¹⁵ English translation: Oil Palm in Agroforestry Systems.

Table 2
Partnership arrangements of *Nikkei* and *Colono* farmers in Tomé-Açu (PA, Brazil).

Group of Farmers	Key Partners	Partnership	Main Goals for Each Partner
Nikkei	<i>Nikkei</i> farmers – Oil Palm Companies	Contract of oil palm cultivation	Nikkei farmers – Better family income and diversified production systems Oil Palm Companies – To increase oil palm fields
	<i>Nikkei</i> Cooperative – SEAGRI – SEMA	Out-scaling SAFTA and Forest Restoration	Nikkei Cooperative – Dissemination of the SAFTA model SEAGRI – To support the SAFTA model SEMA – Forest restoration through agroforestry
	<i>Nikkei</i> Cooperative and farmers – Public Universities and/or Research Institutes	Education, Experiment and Technology	Nikkei Cooperative and farmers – Exchange of information and farming experiments Public Universities – Student training Research Institute – Research experiments
	<i>Nikkei</i> Cooperative – Japanese University	Experiment and Technology	Nikkei Cooperative – To exchange information and training Japanese University – Research and capacity building
	<i>Nikkei</i> farmers – <i>Nikkei</i> Cooperative – Research Institute – Brazilian Cosmetic company	SAF-Dendê (oil palm in Agroforestry Systems)	Nikkei farmers – To recover degraded areas through SAF-Dendê Nikkei Cooperative – To improve the SAFTA model Research Institute – Scientific support Cosmetic company – Sustainable production of vegetable oils through SAF-Dendê for cosmetic purposes
	<i>Nikkei</i> Cooperative – Japanese University – FAO-UN	Out-scaling SAFTA	Nikkei Cooperative – To disseminate the SAFTA model to Africa Japanese University – To transfer technology to Africa FAO-UN – To alleviate poverty and hunger in Africa
	<i>Nikkei</i> Cooperative – Bolivian farmers – Japanese Aid Agency – International Agroforestry Development Agency – Research Institutes – Public Universities	Out-scaling SAFTA	Nikkei Cooperative – Dissemination of the SAFTA model to Latin American countries Japanese Aid Agency – Rural development International Agroforestry Agency – Sustainable farming system Research Institutes – Research and transfer of technologies Public Universities – Student training
Colono	<i>Colono</i> family farmers – Oil Palm Companies – Rural Unions – Bank	Contract oil palm farming (SOPPP)	Colono farmers – Better family income Oil Palm Companies – To expand oil palm fields and social fuel seal or social certification Rural Unions – Contract farming and collective labor agreements Bank – Acquisition of capital through credit and financial transactions
	<i>Colono</i> farmers – SETA – SEAGRI – Public University	Food supply to schools (PNAE)	Colono farmers – To access the market through the National Program for School Meals SETA – To fulfill the legal requirements for purchasing from family farmers SEAGRI – To support the production of family farmers Public University – Food safety standards
	<i>Colono</i> farmers – International cosmetic company	Contract agroforestry crops (vegetable oil)	Colono farmers – To access the international market Cosmetic company – To purchase sustainable vegetable oils from SAF
Nikkei and Colono	<i>Nikkei</i> farmers – <i>Colono</i> farmers	Out-scaling SAFTA	Nikkei farmers – Agroforestry crops (fruit pulp) and public security Colono farmers – Better family income and diversified production systems
	<i>Nikkei</i> Cooperative – <i>Colono</i> communities – SEAGRI – Japanese Aid Agency – Japanese NGO – Mining company	Out-scaling SAFTA and Environmental Conservation	Nikkei Cooperative – Agroforestry production and dissemination of the SAFTA model Colono communities – Better family income and diversified production systems SEAGRI – To support the agroforestry system Japanese Aid Agency – Rural development Japanese NGO – Forest restoration through agroforestry Mining Company – Corporate social responsibility

(continued on next page)

Table 2 (continued)

Group of Farmers	Key Partners	Partnership	Main Goals for Each Partner
	Colono communities – Nikkei Cooperative –International Agroforestry Development Agency – Brazilian cosmetic company	Out-scaling SAF-Dendê	<p>Colono communities – Better family income and diversified farming system</p> <p>Nikkei Cooperative – Agroforestry crops (fruit pulp)</p> <p>International Agroforestry Agency – Sustainable farming system</p> <p>Cosmetic company – Expansion of SAF-Dendê fields</p>

Note: SAFTA (Agroforestry Models of Tomé-Açu) SEAGRI (Municipal Secretariat of Agriculture of Tomé-Açu), SEMA (Municipal Secretariat of the Environment of Tomé-Açu), SETA (Municipal Secretariat of Education of Tomé-Açu).

a special credit line through 25-year contracts and dictates the contractual clauses¹⁶; with the oil palm companies, which are the buyers of the fruit and dictate the cultivation and harvest methods; and with one of the Rural Unions, which offers information and legal advice to prospective farmers and is in charge of issuing the official declaration of the family farmer category (DAP) required by the program¹⁷. Members of the rural union are critical of the length of commitment (25 years) imposed by these contracts. As publically voiced by the Union's leader: "It is a marriage lasting 25 years, not 25 days!".

Despite the restrictive arrangement of this contractual partnership, *Colono* farmers have been able to innovate their oil palm fields. They have experimented with agroforestry techniques in fields that violated the formal procedures formally agreed upon with the oil companies. As illustrated by one *Colono* farmer's comment, "the oil palm field is mine, I must pay the Bank back, not the oil company". The successful practice of intercropping oil palm with annual crops (e.g., cassava, beans, corn) and perennial crops (e.g., *cupuaçu* and cocoa) led the oil companies to loosen their cultivation method restrictions. This innovative behavior seems to be related to the agroforestry model, which is driven by experimentation, as one *Colono* farmer explains referring to *Nikkei* farmers: "farmers here do not wait [take it for granted], that is why they get results, I neither want to be an expert nor some poor little guy". Their agency, however, is possible but limited due to contract conditions. Because of the nature of the production system and the oil companies' monopoly on the market, the bargaining power of out-growers regarding price, production flexibility and labor conditions remains limited.

In contrast with this restrictive state-led partnership arrangement, which drove farmers to adopt oil palm-oriented production system, other policies have created opportunities for *Colono* farmers (particularly females) to engage in another type of contractual-based partnership that is more in line with their farming system. The National Program for School Meals (PNAE)¹⁸, created in 2009 by the federal government, requires that at least 30% of the products used in public school meals are supplied by local family farmers. According to this program, contractual agreements with the local government entitle farmers' associations to supply up to US\$ 3,774/year (R\$ 20,000) per year in food products to local schools¹⁹. This program is coordinated by

the Secretariat of Education (SETA), and is supported by the Secretariat of Agriculture (SEAGRI) – which provides transportation – and the Federal University of Pará (UFPA) – which provides technical assistance with food safety (Table 2 and Fig. 2). Similar to the oil palm program, PNAE's eligibility criteria are based on the family farmer category. Rural Unions and local public agencies offer the technical support needed to issue the required documents (e.g., mapping of their rural properties, registration on the National Rural Land Cadaster system, and issuing of DAP) and comply with the new environmental rules.²⁰

In addition to their influence on farming experimentation in oil palm fields, *Nikkei* farmers have also influenced how *Colono* farmers collaborate with each other and with external actors. The creation of a cooperative among farmers from an agrarian reform settlement to supply to the PNAE program illustrates this process. In the early 2000s, inspired by the SAFTA model, 25 farmers started to cultivate agroforestry products and, in 2016, they created a cooperative and a small agroindustry to process fruit pulp (Table 2 and Fig. 2). As illustrated by a leader of the *Colono* coop, "small-scale farmers must be organized in associations or cooperatives in order to be able to produce and sell".

The partnership arrangement between a *Colono* farmer and an European cosmetic company (farmer-company partnership) is another example of partnership influenced by a leading *Nikkei* farmer. The latter had previous experience working with them, with the PNAE program, and with oil palm companies, which provided him with commercial skills to become a direct supplier of vegetable oil and butter from his organic agroforestry system to the company (Table 2). These different forms of contractual arrangements, influenced directly or indirectly by national policies, illustrate the types of power relations that can emerge between farmers, companies, and state agencies. In the case of the oil palm program, *Colono* farmers sought opportunities to access new markets and credit lines, whereas oil companies were motivated by the benefits of receiving social certification (Social Fuel Seal)²¹ (Table 2). As a symbol of social inclusion and bioenergy production, certification improves the image of oil palm companies and provides access to public subsidies (Schaffel et al., 2012; Brandão et al., 2018). Initially, the farmers' engagement in the program led to experimentation with new agricultural techniques, and to a boost in their self-esteem (Brandão et al., 2018). On the one hand, restrictive rules regarding agricultural practices, dependency on the support of companies and low bargaining power amid fluctuating palm oil prices raised concerns, uncertainty, and distrust among them. In contrast, the PNAE program opened a new market for agricultural products that are more aligned with their production system, with more flexible contractual conditions. The ability

¹⁶ (i) each farmer must cultivate a minimum of 10 hectares of oil palm; (ii) farmers may cultivate subsistence and cash crops and raise animals, but in different plots; (iii) minimum of two male laborers per family (between 16 to 65 years old), and each family farmer may hire one laborer temporarily; (iv) farmers have access to technical assistance provided by palm oil companies (on a monthly basis); and (v) farmers have access to financial credit from the Bank of Amazonia.

¹⁷ DAP (Declaração de Aptidão do Pronaf – DAP) is based on social and economic criteria.

¹⁸ For more information, see <http://www.fnde.gov.br/programas/alimentacao-escolar>

¹⁹ Exchange rate (Jun 18, 2020): US\$ 1.00 = R\$ 5,30

²⁰ According to Federal Law 12.651, May, 25 of 2012, and Decree 7.830/2012, CAR is a legal instrument to monitor economic activities and control deforestation at the level of rural properties. See <http://car.gov.br/public/Manual.pdf>

²¹ The national regulations require the inclusion of a minimum percentage of oil palm production from small-scale farmers (See <http://www.mda.gov.br/sitemda/secretaria/saf-biodiesel/o-selo-combust%C3%ADvel-social>)

to negotiate and adjust their supply according to particular contexts (e.g., product seasonality, access to transportation and labor force) allowed this engagement to become more sustainable. On the other hand, due to the small-scale demand for the products, the program had limited impacts at the regional level.

In the next section, we focus on emerging partnerships between *Colono* farmers and *Nikkei* farmers (Table 2) involving the dissemination of SAFTA agroforestry systems and new forms of commercialization arrangements intended to give *Colono* farmers more economic autonomy.

5.3. *Nikkei* and *Colono* partnerships

Alongside several collaborative models established with external actors, *Nikkei* and *Colono* farmers have gradually converged to co-producing informal and formal partnerships with each other over the years. Social interaction between these two farmer groups emerged and evolved under unequal grounds – many *Colono* farmers were hired by *Nikkei* farmers to work in their black pepper farms (1960-70), Fig. 2), and later in their agroforestry systems (1980-90). In many cases, employment relations have gradually turned into partnerships, with the diffusion and adoption by *Colono* farmers of the techniques used to implement the agroforestry systems of Tomé-Açu (SAFTA) in the last two decades (Table 2 and Fig. 2).

The diffusion of SAFTA was initially proposed by a *Nikkei* farmer, Mr. Michinori Konagano, motivated by the idea that the adoption of this system would provide new economic opportunities for *Colono* farmers, and over time, help address the growing public insecurity. This local leader argued that increased burglary and petty crimes faced by *Nikkei* farmers were a result of the growing inequality in the region. According to him, while *Nikkei* farmers enjoyed the benefits of a successful agroforestry system, *Colono* farmers faced persistent poverty, unemployment, and limited access to markets. He argued that, in order to break the vicious cycle of social and economic deprivations, *Colono* farmers should participate in the expansion of agroforestry economy (Table 2).

Initially, *Colono* farmers received seedlings and technical assistance from CAMTA and the Municipal Secretariat of Agriculture (SEAGRI) and became suppliers of CAMTA's local fruit pulp processing plant (Castro and Fudemma, 2015, Table 2). Later on, this arrangement evolved into a more regular partnership, including training in financial management and product quality. More recently, this initiative has been disseminated regionally through several training programs promoting the transfer of knowledge about the SAFTA model. These programs have received financial and institutional support from multiple external partners, including the Municipal Secretariat of Agriculture (SEAGRI), the Japan International Cooperation Agency (JICA), Brazilian agricultural agencies such as EMBRAPA and CEPLAC, a Japanese environmental NGO (WRS), and a Brazilian cosmetic company (Natura) (Table 2).

Between 2008 and 2013, the Japanese NGO supported the implementation of SAFTA in 12 *Colono* communities of Tomé-Açu. This community-based agroforestry program included the construction of collective seedling nurseries and training on the SAFTA production model. Since 2018, a new model of cultivation of oil palm in agroforestry systems (SAF-Dendê) was initiated, involving multi-lateral partnerships among CAMTA (*Nikkei* Cooperation), *Colono* farmers, an international NGO, and a cosmetic company (Table 2), being also disseminated to other *Colono* communities.

These diverse types of partnership have been relevant to the rural development of the region. In the case of *Nikkei* and *Colono* farmers, for instance, each partner has sought to address different (yet compatible) challenges and goals. *Colono* farmers aimed at improving their farming system to increase family income and reduce economic risks. *Nikkei* farmers aimed at increasing the supply of fruit pulp to CAMTA's processing plant, and at expanding their agroindustry in the region

(Table 2).

Unlike partnerships with outsiders, *Nikkei* and *Colono* farmers have common interest towards the development of sustainable, profitable and inclusive farming systems. However, the former is member of a local elite characterized by strong human capital and both bonding and bridging social capital, and holding more assets (material and non-material). As a result, they have been able to overcome eventual setbacks, and to keep more autonomy. The latter occupies a more vulnerable position characterized by strong bonding social capital within their own communities but low human capital and low bridging social capital. As a result, they have historically been limited to overcome external pressures and to achieve autonomy. The oil palm cultivation is a case in point. *Nikkei*-company partnership is based on more symmetrical relations in comparison to *Colono*-company partnership, which creates dependency of farmers on the company and on bank agricultural loans.

By the same token, the social capital built through the *Nikkei* coop, whose membership is strongly Japanese descent-oriented, creates further challenges to *Colono* farmers. Attempts to open membership to non-*Nikkei* farmers in the past has been faced by internal resistance, but eventually succeeded. Overall, the coop has a limited number of non-*Nikkei* members. *Colono* farmers consider the coop rules very rigid (e.g., sanitary criteria, quality and minimal quantity of products, deadlines), which entail higher costs and can limit their autonomy to commercialize their agroforestry products.

6. COLLABORATION TOWARDS SUSTAINABLE RURAL DEVELOPMENT

Tomé-Açu has become an inspiring social laboratory where numerous collaborative arrangements for developing farming system innovations have been crafted by distinct social actors, farmers, industries, government programs, international donor agencies, and NGOs. *Nikkei* and *Colono* farmers have been at the center of this process.

Differently from rural governance arrangements and development projects led by the State or external non-governmental organizations (Banks et al., 2015; Chapple and Montero, 2016; Chuenpagdee, 2011; Rhodes, 1996; The World Bank, 2006), Tomé-Açu sheds light on how local farmers can maintain their role as protagonists in shaping and reshaping collaborative initiatives. The emergence of the SAFTA entrepreneurial agroforestry system was primarily grounded in the development of new techniques and products among *Nikkei* farmers. SAFTA can be thought of as a 'social-technological complex', which involves a particular philosophy about land use (and Amazonian agriculture), innovative agricultural techniques, processing and added value chains, and a narrative that shows the path to sustainable rural development in the Amazon. The SAFTA social-technological complex has earned *Nikkei* farmers and organizations several prestigious national and international awards and public recognition (see Section 4.1. *Nikkei* Entrepreneurial Farmers). The adoption of this model by *Colono* farmers is based on the autonomy to decide the design of their agroforestry system (crop species) and their preferred commercialization channels, e.g., supplying agroforestry products to CAMTA's processing plant, to the local market, to intermediaries, or to the PNAE program.

The examples presented in this paper show that partnerships cannot be based on blueprints. How collaborations emerge and are shaped depend on the attributes of the actors and the context they take place in, which will be addressed in the next section.

6.1. Differing histories and evolving models of Collective Action and Partnership

The history of collaborations of *Nikkei* farmers is grounded in their cultural identity, traditional knowledge, and migration experience. Cooperatives and associations related to natural resources are a trademark of Japanese farmers (e.g., Shimada, 2014; Ruddle, 1998; McKean,

1992), and have been reproduced in other countries to where they have migrated. With the largest Japanese population outside Japan, Brazil houses thousands of *Nikkei* associations²² promoting Japanese culture (e.g., traditional dancing, music, food, sports, and language) (Asari and Tsukamoto, 2009; Santos and Esaki, 2008). The first cooperative in Brazil was founded by *Nikkei* farmers in 1927 (Taniguti, 2015). In addition to the strengthening of cultural ties and social support, collective organizations have provided knowledge building spaces and institutional support for partnerships with external actors. In Tomé-Açu, two collective organizations – the *Nikkei* Cultural Association and the *Nikkei* Farming Cooperative (Table 1 and Fig. 2) – helped address several local challenges and became the foundation upon which numerous partnerships with actors at the regional, national and international levels were built (Table 2).

In contrast to *Nikkei* farmers, limited institutional capacity has prevented collective actions among *Colono* farmers to have more effective impacts on their farming systems. Nevertheless, collective experiences at the local and regional levels have supported the development of social ties (Table 1), facilitating their engagement in multiple types of partnership, as illustrated in Table 2. The state-led PNAE program, for instance, created opportunities for *Colono* farmers to partner up with municipal governments and supply food products to schools. At the same time, their interest in forming cooperatives and associations has increased, following the example of *Nikkei* farmers, who have been supporting the engagement of *Colono* farmers in agroforestry. The dissemination of the SAFTA model to other rural areas has been offering new opportunities for rural development in the region (Table 2, Fig. 2), as it allows *Colono* farmers to tailor it to their own interests and conditions. In sum, collective actions among groups of farmers and partnerships between them and other actors reinforce each other in a process of rural transformation (Tables 1 and 2).

6.2. The flexibility of agroforestry systems is supporting better social-ecological outcomes

In the context of Eastern Amazon, the examples of SAFTA agroforestry and oil palm production arrangements reveal opportunities and challenges to overcome long-standing structural barriers, promoting the sustainability and fairness of rural development in the region. The diffusion of agroforestry systems reflected the farmers' needs and the local social relations (Castro and Fudemma, 2015), whereas oil palm cultivation reflected the influence of public and private technocratic structures and the global market (Brandão et al., 2018).

The expansion of agroforestry systems in the region has created economic opportunities and access to markets, reduced the pressure on forests and supported the recovery of degraded areas, and promoted the social inclusion of *Colono* farmers. These outcomes have become evident in three types of collaborative initiatives in the region: the emergence of the SAFTA model among *Nikkei* farmers, the diffusion of SAFTA to *Colono* farmers, and the development of a new model of oil palm production based on agroforestry systems (SAF-dendê) (Castellani, 2011). Despite the engagement of private companies, NGOs and state organizations, *Nikkei* farmers kept their autonomy in the design, implementation and governance structure of these initiatives. Their protagonism and ability to promote new initiatives from the bottom up have been an important part of this process, leading them to occupy a central position as agents of sustainable rural development in the Amazon. On the one hand, they are entrepreneurial farmers who are able to promote the addition of value and local access to international markets. On the other hand, they differ from other members of the region's rural elite, whose practices and political strategies lead to deforestation and land-related conflicts with small-scale farmers and indigenous peoples. Despite their asymmetric social and economic

positions, the partnership between *Colono* and *Nikkei* farmers involving SAFTA result in positive outcomes for both groups, allowing them to act as protagonists in the design of their own farming systems and contribute to better social-ecological outcomes.

In contrast, oil palm cultivation continues to prove challenging for *Colono* farmers, partially due to the asymmetric positions of farmers and oil palm companies. Although a few have been able to access new credit lines and markets and increase agricultural productivity as expected (Braga and Fudemma, 2015), contract farming arrangements have created dependency and an unequal share of benefits. Oil companies benefit from associating their name with a social inclusion program and from a larger base of suppliers, whereas *Colono* farmers continue to occupy a vulnerable position, being dependent on a single buyer and bound to a 25-year land use commitment.

Our study shows that these collaborative arrangements should address not only economic constraints, but also the pervasive clientelist structures inserted in the work relations of the local Amazonian population (Weinstein, 1983). Only by breaking the vicious cycle of dependency can small-scale farmers develop more autonomous rural development pathways.

7. FINAL REMARKS

A long history of clientelist relations, boom-and-bust economic cycles, successive failures of development programs, and deficient institutional support have limited the social capital of rural areas in the Brazilian Amazon, fostering distrust in regard to external actors. In contrast, the collaborative arrangements observed in Tomé-Açu – involving both investments in bonding and bridging social capital – reveal a large range of collective initiatives of both *Nikkei* and *Colono* farmers, and partnership between them.

These collaborations have been characterized by hybrid arrangements and bricolage processes of piecing together local practices and bureaucratic procedures (e.g., policies, contracts) (Cleaver and de Koning, 2015). Despite their limited negotiation power, the local farmers were able to make use of external support without losing their autonomous position as crafters and reshapers of innovative land use systems.

Nikkei farmers designed SAFTA, a social-technological complex that has triggered a transformative process of land use systems and new industries for local products in different parts of the region. *Colono* farmers have reshaped palm oil contracts from the top down by developing resistance practices such as intercropping in their oil palm fields (Grossman, 2000), but more important than this is their engagement in creative models of agroforestry practices for consumption and local markets, such as schools.

The expansion of agroforestry systems amid the growth of monoculture and pasture areas in the region represents an alternative led by farmers for the development of more sustainable rural production systems. Likewise, small-scale farmers have been contributing to the progressive transformation of the state-led oil palm program into a more diversified production system that is also more congruent with their needs and possibilities.

Notwithstanding the autonomous rural development pathway based on the expansion of SAFTA, some persistent challenges deserve closer attention. In contrast to the position occupied by *Nikkei* farmers in the rural elite, *Colono* farmers still struggle with the asymmetric power relations in collaborative arrangements (e.g., state-led oil palm programs), and with deficiencies in infrastructure and public services.

A final lesson from this study is related to the different categories of local farmers regarding their social conditions, goals and perceptions, forms of organization, and assets. Despite their different social positions and histories, the shared interest of *Nikkei* and *Colono* farmers in improving the local economic conditions through more sustainable land use practices has been contributing to reshaping not only the rural landscape, but also social relations and the economy of the region.

²² For more information, see <http://www.kenren.org.br/>

Different authors have stressed the importance of social capital to support horizontal and vertical institutional connections as well as nested social network and institutions to both local and regional development challenges (Brondizio et al., 2009; Woolcock and Narayan, 2000). Although local bonding social capital are important to achieve some common goals, institutional arrangements bridging local and regional efforts are necessary to advance long-term rural sustainable development.

While *Colono* farmers built strong bonding social capital based on community-based initiatives, *Nikkei* farmers have invested in forming both strong bonding and bridging social capital. These include creating and consolidating their branded agroforestry system (SAFTA), controlling value-aggregation locally, expanding their market nationally and internationally, and more recently, disseminating their farming knowledge to other regions and countries. Local governance arrangements in Tomé-Açu, based on both investment in local institutions and multi-stakeholders collaborations, show a potential path to overcome historical setbacks that have limiting sustainable farming development in the Amazon. In the past, all these efforts have been recognized in State-level programs and initiatives. It remains to be seeing whether, under the renewed government, focusing on deforestation and currently dismantling the Brazilian environmental governance system, local initiatives will be able to succeed in their long-enduring pathway to sustainable rural development of the Amazon.

Acknowledgements

The authors gratefully acknowledge the support of the FAPESP (n. 12/51045-1, n. 16/07756-1, n. 18/50041-9), CNPq (n. 482599/2012-0), ENGOV (European Commission within the 7th framework program under grant agreement): no. FP7-SSH-CT-2010-266710 for research funds, and of the AGENTS Project: Amazonian Governance to Enable Transformations to Sustainability, which is part of the Belmont Forum and NORFACE T2S Program and funded by FAPESP (Brazil), National Science Foundation (USA), NWO (The Netherlands), and Vetenskapsradet (Sweden). We thank NEPAM - UNICAMP (Brazil), CEDLA – Amsterdam University (The Netherlands) and CASEL – Indiana University (USA) for their academic support and Nathália Moreira dos Santos for field assistance and for elaborating maps (FAPESP Technical Training III Fellowship, n. 18/13444-8). We owe gratitude to all people from Tomé-Açu region and Belém (state of Pará) and all other key informants for making the collection of data possible. The authors assume full responsibility for the content presented in this study.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.landusepol.2020.104999>.

References

- Abramovay, R., Magalhães, R., 2008. Access of family farmers to biodiesel markets: Partnerships between large companies and social movements. *Recovering Markets Innovative Practice series*. IIED, London, pp. 32.
- Agrawal, A., 1996. Group Size and Successful Collective Action: A Case Study of Forest Management Institutions in the Indian Himalayas. In: Gibson, C., Mean, M., McKean, A., Ostrom, E. (Eds.), *Forest Resources and Institutions*, pp. 49–74.
- Asari, A.Y., Tsukamoto, R.Y., 2009. Migração, Território, as Associações Nipo-Brasileiras do Norte do Paraná (in Portuguese). Paper presented at Observatório Geográfico América Latina. <http://www.observatoriogeograficoamericalatina.org.mx/egal12/Geografiasocioeconomica/Geografiadelapoblacion/01.pdf>.
- Banks, N., Hulme, D., Edwards, M., 2015. NGOs, States, and Donors Revisited: Still Too Close for Comfort? *World Development* 66, 707–718. <https://doi.org/10.1016/j.worlddev.2014.09.028>.
- Barnard, D.G.N., 2014. The role of social capital in household economy and land use and cover change in areas of land reform in Santarém, Brazilian Amazon. Unpublished doctoral dissertation. Indiana University Bloomington, pp. 387.
- Barros, A.V.L., Homma, A.K.O., Takamatsu, J.A., Takamatsu, T., Konagano, M., 2009. Evolução e Percepção dos Sistemas Agroflorestais Desenvolvidos pelos Agricultores Nipo-Brasileiros do Município de Tomé-Açu, Estado do Pará (in Portuguese). *Amazônia: Ci. & Desen. v. 5* (9), 121–151. <http://www.alice.cnptia.embrapa.br/alice/handle/doc/783288>.
- Batistella, M., Bolfe, E.L., Moran, E.F., 2012. Agroforestry in Tomé-Açu: An Alternative to Pasture in the Amazon. In: Brondizio, E.S., Moran, E.F. (Eds.), *Human-Environment Interactions: Current and Future Directions*. Springer, Dordrecht, pp. 321–342.
- Bodin, O., 2017. Collaborative Environmental Governance: Achieving collective action in socio-ecological systems. 2017. *Science* 357 (659). <https://doi.org/10.1126/science.aan1114>.
- Braga, A.C.R., Fudemma, C., 2015. Pluralidade da Assistência Técnica e Extensão Rural: Pública, Privada e de Organizações da Sociedade Civil (in Portuguese). *RURIS* 9 (2), 239–268. <https://www.ifch.unicamp.br/ojs/index.php/ruris/article/view/2300>.
- Brandão, F., De Castro, F., Fudemma, C., 2018. Between Structural Change and Local Agency in the Palm Oil Sector: Interactions, Heterogeneities and Landscape Transformations in the Brazilian Amazon. *Journal of Rural Studies* 71, 156–168. <https://doi.org/10.1016/j.jrurstud.2018.09.007>.
- Brondizio, E.S., 2012. Institutional Crafting and the Vitality of Rural Areas in an Urban World: Perspectives from a Japanese Community in the Amazon. *Global Environmental Research*. 16, 145–151.
- Brondizio, E.S., 2009. Agriculture Intensification, Economic Identity, and Shared Invisibility In Amazonian Peasantry: Caboclos, Colonists in Comparative Perspectives. *Amazon Peasant Societies in a Changing Environment – Political Ecology, Invisibility and Modernity in the Rainforest*. Springer, pp. 181–214.
- Brondizio, E.S., 2008. 2017. *The Amazonian Caboclo and the Açaí palm: Forest Farmers in the Global Market*. New York Botanical Garden Press, New York, USA, pp. 402 [2017 ebook edition].
- Brondizio, E.S., Ostrom, E., Young, O., 2009. Connectivity and the Governance of Multilevel Socio-Ecological Systems: The Role of Social Capital. *Annu. Rev. Environm. Resources*. 34, 253–278. <https://doi.org/10.1146/annurev.enviro.020708.1.00707>.
- Brondizio, E.S., Cak, A., Caldas, M., Mena, C., Bilsborrow, R., Fudemma, C., Moran, E.F., Batistella, M., Ludewigs, T., 2009. Small Farmers and Deforestation in Amazônia. In: Keller, M., Bustamante, M., Gash, J., Silva Dias, P. (Eds.), *Amazônia and Global Change*. World Scientific Publishing/Geoph, Monograph, Series 186, Washington, DC, pp. 117–143.
- Brosius, J.P., Tsing, A.L., Zerner, C., 1998. Representing communities: Histories and politics of community-based natural resource management. *Society and Natural Resource* 11 (2), 157–188. <https://doi.org/10.1080/08941929809381069>.
- Callo-Concha, D., Denich, M., 2014. A participatory framework to assess multifunctional land-use systems with multicriteria and multivariate analyses: A case study on agrobiodiversity of agroforestry systems in Tomé-Açu. *Brazil. Change Adaptation Socioecol. Syst.* 1, 40–50. <https://doi.org/10.2478/cass-2014-0005>.
- CAMTA, 1967. *Relatos Históricos da Cooperativa Agrícola Mista de Tomé-Açu (in Portuguese)*. Belém, Pará.
- Castellani, D.C., 2011. Relacionamento entre produtor e empresa: da pesquisa à Comercialização (in Portuguese). Paper presented at Congresso Brasileiro de Olericultura. 51 29 Horticultura Brasileira, Viçosa, MG, Brazil. http://www.abhorticultura.com.br/eventos/trabalhos/ev_5/Debora_Castellani_Relacionamento_produtores_emp.pdf.
- Castellani, D., Monteiro, R.E., Takamatsu, J.A., Kato, O.R., Rodrigues, M.R.L., Miccolis, A., Costa, M., Casara, J., 2009. Estudos de Sistemas Agrossilviculturais para a Produção de Dendê (*Elaeis guineensis*) em Propriedades Rurais de Tomé-Açu (PA) (in Portuguese). Paper presented at Congresso Brasileiro de Sistemas Agroflorestais/EMBRAPA-CPATU. <http://www.alice.cnptia.embrapa.br/handle/doc/657675>.
- Castro, C.E.F., Bulisani, E.A., Pettan, K.B., Carbonell, S.M., Maia, M.S.D., 2005. *Pontes para o futuro (in Portuguese)*. CONSEPA, Campinas, SP, Brazil.
- Castro, F., 2014. Environmental policies in the Lula Era: Accomplishments and Contradictions. In: Castro, F., Koonings, K., Wisebron, M. (Eds.), *Brazil under the Workers' Party: Continuity and Change from Lula to Dilma*. Palgrave Macmillan, Hampshire, USA, pp. 229–255. https://doi.org/10.1057/9781137273819_11.
- Castro, F., Hogenboom, B., Baud, M., 2016. Environmental Governance in Latin America. Palgrave MacMillan, Hampshire, England. <https://doi.org/10.1057/9781137505729>.
- Castro, F., Fudemma, C., 2015. Farming Knowledge building between migrant and local peasants in the Eastern Amazon. In: Paper presented at XVth Biannual Conference of the International Association for the Study of the Commons: The Commons Complexity and Change. Edmonton Alberta. Canada.
- Castro, F., Fudemma, C., 2014. In: *The Biodiesel program and territorial reconfiguration in Eastern Amazon*, Brazil Paper presented at 2014 Global Land Project Open Science Meeting: Land transformations: between global challenges and local realities. Berlin, Germany. IGBP-IHDP.
- Cleaver, F.D., de Koning, J., 2015. Furthering critical institutionalism. *International Journal of the Commons* 9 (1), 1–18. <https://www.jstor.org/stable/26522813>.
- Chapple, K., Montero, S., 2016. From Learning to fragile governance: Regional economic development in rural Peru. *Journal of Rural Studies*. 44, 143–152. <https://doi.org/10.1016/j.jrurstud.2016.01.009>.
- Chuenpagdee, R., 2011. Interactive Governance for Marine Conservation: An Illustration. *Bulletin of Marine Science*. 87 (2), 197–211. <https://doi.org/10.5343/bms.2010.1061>.
- Feiock, R.C., 2013. The Institutional Collective Action Framework. *Policy Studies Journal* PSJ. 41 (3), 397–425. <https://doi.org/10.1111/psj.12023>.
- Gomes, G.M., Vergolino, J.R., 1997. Trinta e cinco anos de crescimento econômico na Amazônia (1960-1995) (in Portuguese). Texto para Discussão nº 533. IPEA, Brasília, DF, Brazil, pp. 146.
- Grossman, L.S., 2000. *The Political Ecology of Bananas: Contract Farming, Peasants, and Agrarian Change in the Eastern Caribbean*. The University of North Carolina Press, Chapel Hill, pp. 296.

- Guedes, G.R., Brondízio, E.S., Barbieri, A.F., Anne, R., Penna-Firme, R., D'Antona, A.O., 2012. Poverty and Inequality in the Rural Brazilian Amazon: A Multidimensional Approach. *Human Ecology* 40 (1), 41–57. <https://doi.org/10.1007/s10745-011-9444-5>.
- Homma, A.K.O., 2015. Sinergias de mudanças para uma nova agricultura na Amazônia (in Portuguese). In: Vieira, I.C.G., Jardim, M.A.G., Rocha, E.J.P. (Eds.), *Amazônia em tempo: estudos climáticos e socioambientais* (in Portuguese). Universidade Federal do Pará/Museu Paraense Emílio Goeldi/Embrapa Amazônia Oriental, Belém, PA, Brazil, pp. 51–80.
- Homma, A.K.O., 2004. Dinâmica dos Sistemas Agroflorestais: O caso da colônia agrícola de Tomé-Açu. *Revista do Instituto de Estudos Superiores, Pará*. www.ainfo.cnpia.embrapa.br.
- Homma, A.K.O., Furlan Jr., J., 2001. Desenvolvimento da dendeicultura na Amazônia: Cronologia (in Portuguese). In: Müller, A.A., Furlan Jr.J. (Eds.), *Agronegócio do dendê: uma alternativa social econômica e ambiental para o desenvolvimento sustentável da Amazônia*. Embrapa Amazônia Ocidental, Belém, PA, Brazil, pp. 193–201.
- IDESP, 2014. *Estatística Municipal – Tomé-Açu. Governo do Estado do Pará. Secretaria de Estado do Planejamento, Orçamento e Finanças* (in Portuguese). pp. 47.
- Jos, B., Lennox, G.D., Ferreira, E., et al., 2016. Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature/Letter*. <https://doi.org/10.1038/nature18326>.
- Koiman, J., 1993. *Modern Governance: New Government-Society Interactions*. SAGE Publishing, London, pp. 280.
- Koopmans, M.E., Rogge, E., Mettepenningen, E., Knickel, K., Sumane, S., 2018. The Role of Multi-actor Governance in Aligning Farm Modernization and Sustainable Rural Development. *Journal of Rural Studies* 59, 252–262. <https://doi.org/10.1016/j.jrurstud.2017.03.012>.
- Levi, M., 1996. Social and Unsocial Capital: A Review Essay of Robert Putnam's Making Democracy Work. *Politics & Society*. 24, 45–55. <https://doi.org/10.1177/0032329296024001005>.
- Long, N., 2001. *Development Sociology: actor perspectives*. Routledge Publisher, London, pp. 309.
- McKean, M., 1992. Traditional Japanese Commons Lands (Iriaichi) in Japan. In: Bromley, D.W. (Ed.), *Making the Commons Work: Theory, Practice and Policy*. ICS, San Francisco, pp. 63–98.
- Morsello, C., Adger, W.N., 2007. Do Partnership between large corporations and Amazonian Indigenous Group help or hinder communities and forests? In: Ros-Tonen, M.A.F., van den Hombergh, H., Zoomers, A. (Eds.), *Partnerships in Sustainable Forest Resource Management. Learning from Latin America*, Brill, Leiden, pp. 147–167. <https://doi.org/10.1163/ej.9789004153394.i-329.65>.
- Narrod, C., Roy, D., Okello, J., Avedaño, J., Rich, K., Thorat, A., 2009. Public-Private partnerships and collective action in high value fruit and vegetable supply chains. *Food Policy*. 34, 8–15. <https://doi.org/10.1016/j.foodpol.2008.10.005>.
- Netting, R.M.C., 1993. *Smallholders, Householders: Farm families and the Ecology of Intensive, Sustainable Agriculture*. Stanford University Press, Stanford, pp. 389.
- Nugent, S., 2009. Utopias and Dystopias in the Amazonian Social Landscape. In: Adams, C., Murrieta, R., Neves, W., Harris, M. (Eds.), *Amazon Peasant Societies in a Changing Environment – Political Ecology, Invisibility and Modernity in the Rainforest*. Springer, pp. 21–32.
- OECD, 2015. *OECD Environmental Performance Review: Brazil 2015*. OECD Publishing, Paris. https://www.oecd-ilibrary.org/environment/oecd-environmental-performance-reviews-brazil-2015_9789264240094-en.
- Ostrom, E., 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press, Cambridge, pp. 280.
- Ostrom, E., Ahn, T.K., 2003. *Foundations of Social Capital*. An Elgar Research Collection, Northampton, MA, USA, pp. 590.
- Park, H.J., Feiock, R.C., 2005. Collaborative Approaches to Economic Development: Regional Development Partnerships and Social Capital. Paper present at the Annual Meeting of the American Public Administration Annual Meeting 31 April 2-5.
- Piekielek, J., 2010. Cooperativism and Agroforestry in the Eastern Amazon: The Case of Tomé-Açu. *Latin American Perspectives*. 37 (12), 12–29. <https://doi.org/10.1177/0094582X10382097>.
- Putnam, R.D., 1993. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton University Press, Princeton, pp. 257.
- Repórter Brasil, 2013. *Expansão do Dendê na Amazônia Brasileira: Elementos para uma análise dos impactos sobre a agricultura familiar no nordeste do Pará* (in Portuguese). ONG Repórter Brasil/FASE, São Paulo, SP, Brazil. <https://reporterbrasil.org.br/documentos/Dende2013.pdf>.
- Rhodes, R.A.W., 1996. The New Governance: Governing without Government. *Political Studies*. XLIV, pp. 652–667. <https://doi.org/10.1111/j.1467-9248.1996.tb01747.x>.
- Ruddle, K., 1998. Traditional Community-based coastal marine fisheries management in Viet Nam. *Ocean & Coastal Management*. 40, 1–22. [https://doi.org/10.1016/S0964-5691\(98\)00072-6](https://doi.org/10.1016/S0964-5691(98)00072-6).
- Sanches, R.A., Futeemma, C.R.T., Alves, H.Q., 2020. Indigenous Territories and Governance of Forest Restoration in the Xingu River (Brazil). Special Issue Governing Forest Landscape Restoration. *Land Use Policy*. <https://doi.org/10.1016/j.landusepol.2020.104755>.
- Santos, R.A., Esaki, F.M., 2008. A propagação da cultura japonesa através das associações culturais em Marília (in Portuguese). *Revista Científica Eletrônica de Turismo*. V (9), 1–5. http://faef.revista.inf.br/imagens_arquivos/arquivos_destaque/R07htO5ynwpbfH8_2013-5-22-15-53-6.pdf.
- Sauer, S., 2019. Rural Brazil during the Lula Administrations: Agreements with Agribusiness and Disputes in Agrarian Policies. *Latin American Perspectives* 46 (4), 103–121. <https://doi.org/10.1177/0094582X16685176>.
- Schaffel, S., Herrera, S., Obermale, M., La Rovere, E.L., 2012. Can family farmers benefit from biofuel sustainability standards? Evidence from the Brazilian Social Fuel Certificate. *Biofuels*. 3 (6), 725–736. <https://doi.org/10.4155/bfs.12.67>.
- Schlager, E., Blomquist, W., 1998. Resolving Common Pool Resource Dilemmas: Heterogeneities among Resources Users. In: Paper presented at Seventh Common Property Conference of the International Association of Common Property. British Columbia, Canada. June 10-14.
- Shimada, D., 2014. External impacts on traditional commons and present-day changes: a case study of *iriai* forests in Yamaguni district, Kyoto, Japan. *International Journal of the Commons*. 8 (1), 207–235. <https://www.jstor.org/stable/26523158>.
- Siisiainem, M., 2000. Two Concepts of Social Capital: Bourdieu vs. In: Paper presented at ISTR Fourth International Conference "The Third Sector: For What and for Whom?". Trinity College, Dublin, Ireland. Putnam July 5-8.
- Sobreiro-Filho, J., 2019. *Disputa e Violência em Carne, Osso e Territórios na Amazônia Paraense: Assassinatos, Confrontos Políticos e Movimentos Socioterritoriais*. (in Portuguese). XIII ENANPEGE: A Geografia Brasileira na Ciência-Mundo, São Paulo-SP, Brazil Sep 2-7, 2019.
- Taniguti, G.T., 2015. *Cotia: imigração, política e cultura* (in Portuguese). PhD dissertation. University of São Paulo, pp. 332. <http://www.teses.usp.br/teses/disponiveis/8/8132/tde-16072015-122819/en.php>.
- The World Bank, 2006. *Stakeholders, Power Relations, and Policy Dialogue: Social Analysis in Agriculture Sector, Poverty and Social Impact Analysis*. Report n. 34496-GLB, Washington DC, pp. 67.
- Toledo, E.D.N., Vieira, I.C.G., Aguiar, A.P.D., Araújo, R., 2017. Development paradigms contributing to the transformation of the Brazilian Amazon: do people matter? *Current Opinion in Environmental Sustainability* 26-27, 77–83. <https://doi.org/10.1016/j.cosust.2017.01.009>.
- Tura, L., Costa, F., 2000. *Campesinato e estado na Amazônia: impactos do FNO no Pará* (in Portuguese). Brasília Jurídica & FASE, Brasília, Brazil, pp. 381.
- Tzanakis, M., 2013. Social Capital in Bourdieu's, Coleman's and Putnam's Theory: empirical evidence and emergent measurement issues. *Educate* 13 (2), 2–23. <http://educatejournal.org/index.php/educate/article/view/366>.
- van der Have, R.P., Rubalcaba, L., 2016. Social Innovation Research: An emerging area of innovation studies? *Research Policy*. 45 (9), 1923–1935. <https://doi.org/10.1016/j.respol.2016.06.010>.
- Weinstein, B., 1983. *The Amazon rubber boom, 1850-1920*. Stanford University Press, Stanford, USA, pp. 356.
- Wellbrock, W., Roep, D., Mahon, M., Kairyte, E., Nienaber, B., García, M.D.D., Kriszan, M., Farrell, M., 2013. Arranging Public Support to Unfold Collaborative Modes of Governance in Rural Areas. *Journal of Rural Studies* 32, 420–429. <https://doi.org/10.1016/j.jrurstud.2013.10.002>.
- Woolcock, M., Narayan, D., 2000. Social Capital: Implications for Development Theory, Research, and Policy. *The World Bank Research Observer*. 15 (2), 225–249. <https://doi.org/10.1093/wbro/15.2.225>.
- Varughese, G., Ostrom, E., 2001. The Contested Role of Heterogeneity in Collective Action: Some Evidence from Community Forestry in Nepal. *World Development* 29 (5), 747–765. [https://doi.org/10.1016/S0305-750X\(01\)00012-2](https://doi.org/10.1016/S0305-750X(01)00012-2).
- Yamada, M., Gholz, H.L., 2002. An Evaluation of Agroforestry Systems as a Rural Development Option for the Brazilian Amazon. *Agroforestry Systems*. 55, 81–87. <https://doi.org/10.1023/A:1020523107243>.
- Yamada, M., 1999. *Japanese immigrant agroforestry in the Brazilian Amazon: a case study of sustainable rural development in the Tropics*. Ph.D. dissertation. University of Florida, Gainesville, pp. 820.