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How and why did the transition process towards a fully sustainable production of cocoa beans in Bahia (Brazil) take place?

RESEARCH ARTICLE

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Abstract

This paper theoretically models and empirically assesses the sociotechnical transition process experienced by a group of producers in southern Bahia State (Brazil). Driven by the search for economic sustainability in cocoa production, this group has achieved full sustainability through production chain upgrading, enabling the agroforestry system's (cabruca) continuity in their properties. In order to understand how and why this process happened, our conceptual model advances on the Multi-Level Perspective (MLP) framework, as it is an applied way of analyzing different niche transformations within the same regime, a typical situation in agrifood systems in emerging markets. Our analyses and empirical evidence suggest that interpersonal relationships play a crucial role in this process, particularly developing concepts and strategies, and in establishing operational structures. Rules and structure formalization may replace interpersonal relationships, as observed when the transition goes forward. Our findings evidence knowledge gathering, cooperation among actors, and information and support exchanging as critical factors to trigger the niche transition process.

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1. Introduction

Tropical forest destruction is one of the significant causes of biodiversity degradation in the world. In Brazil, the extent of forestry ecosystems' conversion into other uses has consequences for biodiversity and local population survival and well-being (Piasentin and Góis, 2016).

Although most researchers concentrated on forest loss in the Amazon, the Brazilian Atlantic Forest ecosystem is among the richest and most threatened on the planet. Atlantic Forest is the second largest forest in Brazil, covering the east, southeast, and south coasts. Bahia State's southeast region concentrates most of the ecosystem's remnants within the Brazilian Northeast (Sambuichi *et al*., 2007). Cocoa growing areas concentrate most of those remnants in the *cacau-cabruca*, or *cabruca*, agroforestry system (AFS) (Piasentin and Góis, 2016). *Cacau-cabruca* is a regional term used to characterize a cocoa plantation method in which cultivation occurs in the primary forest understory. Unlike productivity-geared agricultural models, which bring intensive use of capital and agrochemicals — and the natural resource degradation that comes along — *cacau-cabruca* is a valuable resource for wild biodiversity, flora, and fauna conservation.

Albeit environmentally sustainable, *cacau-cabruca* is under threat due to economic and social factors. More intensive production methods, such as monoculture, bring greater production control and up to 40% higher productivity (Armengot *et al.*, 2017). Lack of financial resources also places a challenge, particularly for small-scale producers (21%) and family farmers (69%), who count for the vast majority (90%) of the 22 thousand cocoa producers in Bahia (CEPLAC, 2015). An alternative strategy is required to grant *cabruca* full sustainability in this scenario. Full sustainability refers to economic, social, and environmental dimensions (Elzen, 2020).

This study analyses the socio-technical transition process experienced by producers in southern Bahia State. Driven by the search for economic sustainability in cocoa production, this group has achieved full sustainability through production chain upgrading, enabling *cabruca*'s continuity in their properties. This agroforestry system transition analysis is relevant, as it may be a model for understanding how socio-technical changes can happen in AFSs. Furthermore, this becomes even more important when we consider that most of those systems' locations are in poor and developing countries and frequently are formed by small-scale producers.

The study also contributes to the discussion on complex transitions, as it analyzes an agroforestry system (cocoa) socio-technical transition in a tropical forest. How did the process happen? Which were the main drivers and key factors motivating the transition? What has started and enabled these dynamics?

Despite numerous studies analyses the complex transitions and their intermediaries (Avelino, 2009; de Haan and Rotmans, 2011; Fuenfschilling and Truffer, 2014; Hargreaves *et al.*, 2013; Hodson *et al.*, 2013; Hodson and Marvin, 2010; Jhagroe, 2016; Klerkx and Aarts, 2013; Kivimaa, 2014; Kivimaa and Martiskainen, 2018; Loorbach, 2009, 2010; Rotmans *et al*., 2010; Seyfang *et al.*, 2014; Voß *et al*., 2009; Wentink *et al.*, 2017), only a few of them explicitly address this complexity under a practical perspective, particularly when it comes to agriculture (Kivimaa *et al.*, 2019), and, even more specifically, to agroforestry systems.

This study delivers results through empirical inputs and contributes to a conceptual model to support the transition towards a whole sustainability process in an agroforestry system. That enables the rise of new questions and indicates avenues for further research in the future.

The research consisted of a qualitative approach to study the case of the genesis of a consortium dedicated to producing and commercializing premium cocoa through *the cabruca* method in Southern Bahia. We conducted interviews with farmers and stakeholders to collect the primary data in a webinar series devoted to *cabruca*'s potential and challenges. The study was based on Multi-Level Perspective (MLP), the most frequently applied research line in socio-technical transitions literature. MLP's appeal lies in the ability

this approach has to deal with large-scale socio-technical systems dynamics, as well as the sustainability challenges they represent (Smith *et al.*, 2010).

The theoretical foundation follows this introduction. With the literature review as a starting point, we will structure the conceptual model for analyzing the transition toward fully sustainable production in an agroforestry chain. The methodology is described in further detail, followed by the case study examination. Finally, the analysis and conclusions of the results are laid out.

2. Theoretical foundation

Socio-technical transitions literature introduced by Rip and Kemp (1998), Geels (2002, 2005a,b, 2006a,b), and some others (Rotmans, 2005; Smith *et al.*, 2005) is increasingly utilized as a reference to approach unsustainability issues, because this framework identifies how changes towards more sustainable states may be fostered (Elzen *et al.*, 2004; Farla *et al.*, 2012; Hoogma *et al.*, 2002).

Research on transitions focuses on understanding radical socio-technical changes (Sutherland *et al.*, 2014), changes that outdo the system, and going beyond the current order (Schiller *et al.*, 2014). These radical changes are usually linked to measures adopted when facing challenges and opportunities that arise within the system and include restrictions or incentives for sustainability transition (Elzen *et al.*, 2020).

According to Kanger and Schot (2016), transitions happen in three phases:

- Pre-development and Exploration: Experimentation, usually a quick and small-scale exploratory action (Kivimaa *et al.*, 2017), may happen relatively quickly, even in change-resistant socio-technical regimes. Niche technologies are not yet perceived as a threat by regime actors (Kanger and Schot, 2016).
- Acceleration and incorporation: Structure changes become visible through a build-up of sociocultural, economic, ecological, and institutional changes. Collective learning and increasing returns take place.
- Stabilization: Entails a diminishing social change pace when and new dynamic equilibrium is reached (Rotmans *et al.*, 2001) and "a former niche has established itself as a new regime" (Kanger and Schot, 2016: p. 600).

2.1 MLP elements conceptualization and operationalization

MLP approaches radical socio-technical innovations (transitions) as an interaction among three levels: niche, regime, and landscape. Niche may be interpreted as a new market, technologies, rules and legislations, organizations, or even projects, concepts, or ideas within a system (Loorbach, 2007). Furthermore, they may be intertwined in changes related to new technologies and practices, configurations of actor groups, beliefs and values, networks, and policies (Darnhofer, 2014). In the agri-food sector, niche innovations include alternative foods systems (El Bilali, 2019; de Lima Medeiros *et al.*, 2020; Piao *et al.*, 2021) such as organic agriculture (Hauser and Lindtner, 2017; Vila Seoane and Marin, 2017) and agroecology (Duru *et al.*, 2014; Isgren and Ness, 2017).

The regime, in its turn, may be understood as a particular set of shared practices, rules, and assumptions that dominate the system and its actors (Rotmans *et al.*, 2001). Systems encompass interconnected economic, social, cultural, infrastructural and regulatory subsystems, which are associated with various social groups (Bergman *et al.*, 2008; Geels, 2005a). Social systems' stability and cohesion are established and strengthened through cognitive, normative, and regulatory institutions (Geels, 2005b). It is essential to highlight that regimes, in general, focus on system optimization, as opposed to focusing on innovation, because habits, existing competencies, past investment, regulation, prevailing norms, and worldviews act together to determine behavior patterns (Geels, 2005b; Smith *et al.*, 2005).

Typically agri-food regime elements include commercial codes and regulations, food safety laws, existing commercial networks, logistic transportation and infrastructure (El Bilali, 2019). Järnberg *et al.* (2018: p. 412) suggest that "… regime includes government key actors and their associated institutional structures in the agricultural sector, the political rhetoric on agricultural development, dominant agriculture practices, and the associated patterns of exosystemic services and human well-being". Regime elements may be tangible (like laws, regulations, protocols, and standards) or intangible (like culture, political paradigms, shared visions and beliefs, social norms, and cognitive routines) (Geels, 2011). Regime stabilization strategies include lobbying, network, and alliance constitution (Duineveld *et al.*, 2009). Therefore, the analysis also spotlights actor networks and social groups that support the dominant agri-food system (El Bilali, 2019).

As the third level, MLP has conceived landscape as a vast exogenous environment that goes beyond the regime's and niche actors' direct influence (Geels, 2010). The landscape level addresses various trends and exogenous factors that affect the transition to sustainable agri-food systems (El Bilali, 2019; Elzen, 2012; 2020). The emphasis on globalization and internationalization of the agri-food market, population growth, financial crisis, changes in diet and lifestyle, (neo-) liberalization, international treaties and conventions, growing concerns about animal welfare and the environment, climate change (El Bilali, 2019; Konefal, 2015) are examples of this type of exogenous factors. According to Immink *et al.* (2013: p. 153), "… cultural values, economic and commercial international rules, macro-political developments, and new global standards are part of landscape movements that might lay pressure on the current sector". Lutz and Schachinger (2013) invite the consideration of not only the socioeconomic landscape but also the biophysical landscape (like climate change, arable land availability, and soil fertility) in studies that deal with agri-food sustainability transitions. MLP sets three general dimensions to characterize both regime and landscape (Geels, 2004): technological (components, devices, infrastructure); social (networks and actors, that is, individuals, organizations, and their roles); and institutional (institutions in general, rules — be it formal (including regulations) or informal).

MLP also posits that niche-regime-landscape interactions shape sustainability transitions and determine their scope and impact. Niche-regime interactions may address different dimensions: technological, social, and institutional (El Bilali, 2019; Elzen *et al.*, 2012). It is possible to claim that niches and regimes are about networks and actor groups aligned and abide by a set of rules and practices, about how actors interact and build — or not — bridges that may lead to the system reconfiguration (Feyereisen *et al.*, 2017), what resonates with "anchoring" mechanisms suggested by Elzen *et al.* (2012). For these scholars, the term "anchoring" conceptualize emerging forms of connection; that is, anchoring is about the link between a novelty and the existing structures and institutions. Therefore, anchoring might happen between a niche and a regime or within a niche like, for example, transformation observed in niche actors (worldviews, values, organization) when going through transitions towards more sustainable agricultural systems (Chizallet *et al.*, 2018; Coquil *et al.*, 2017; Cristofari *et al.*, 2017; Dupré *et al.*, 2017; Lamine, 2011; Toffolini *et al.*, 2019).

Elzen *et al.* (2012) propose three anchoring types: technological, network, and institutional. The latter may be classified as cognitive (related to social values and interests), normative (social values translation into formal and informal rules), and economic (like contracts, trusts, value chains, and business networks). Institutional anchoring means that developments within a niche are translated into new or adapted rules (interpretative, normative, or economic), which play — at least temporarily — a role in guiding niche and regime actors' activities. (Elzen *et al.*, 2012).

MLP analyzes transitions as an interaction and arising development at landscape, regime, and niche levels. During transitions, all three dimensions (technological, social, and institutional) go through changes and influence each other (Elzen *et al.*, 2020): therefore, a general systemic view of the transition process is paramount.

3. Conceptual model

Based on MLP, we have elaborated a conceptual model to support understanding the transition towards sustainability process in an agricultural value chain. In this model, we approach MLP through a systemic view, as represented in Figure 1.

The model seeks to integrate MLP levels — illustrating technological (tec), institutional (inst), and human-social (hs) dimensions, which make up regimes (R_tec, R_inst, and R_hs) and niches (N_tec, N_inst, and N_hs) — to full sustainability dimensions: environmental (S_env), institutional (S_inst), and social (S_soc) (Elzen *et al.*, 2020; Sutherland *et al.*, 2014). External trends and exogenous factors at the landscape level may arise, generating opportunities or tensions in the regime or the niche. Those factors may be socioeconomic (P_se) and biophysical (P_bio) and function as change triggers. A transition towards sustainability is highly complex, and to be lasting, it needs to happen in all three sustainability dimensions (economic, social, and environmental). The proposed model allows us to place the niche in the sustainability dimensions at the moment t_1 and later at the moment t_2. The transition path is represented by a spiral, showcasing the necessary niche-regime interactions and transactions so that the niche can perform the transition toward complete sustainability. At both levels, niche-regime constant interactions and transactions happen within technological, human-social, and institutional dimensions. From the interactions between niches and regimes, anchoring may crop up: anchoring would be the connections between novelty and system structures. Anchoring may be technological (A_tec), network (A_net), and institutional (A_inst). This mechanism enables the system to transition toward sustainability. The transactions and interactions between regime and niche actors, or among actors within the niche, may leverage the transition process, promoting the niche's "movement" towards a full sustainability position.

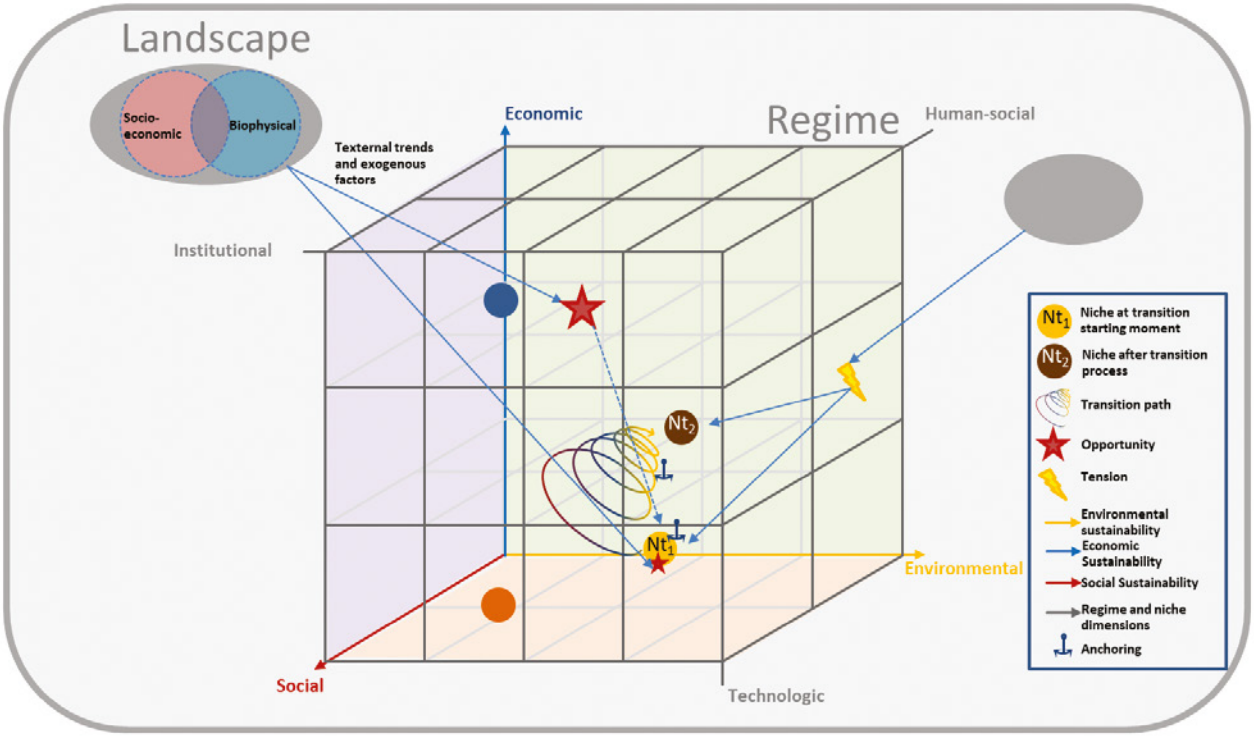

Figure 1. Conceptual model. Source: Based on models proposed by Elzen *et al.* (2012) and Geels (2005a,b).

4. Methodology

This study employs a single case study design (Eisenhardt *et al.*, 2007; Yin, 2014), conducting exploratory research to gather information on the transition process of a group of cocoa farmers in Southern Bahia. The group has adopted the *cabruca* system to produce high-quality cocoa. While laboratory experiments isolate phenomena from their contexts, case studies emphasize the abundance of the natural world in which they occur (Eisenhardt *et al.*, 2007). We followed Agarwal *et al.* (2020) to investigate in-depth. Qualitative approaches are suitable for assessing ongoing transitions, as they enable the exploration of complex issues and processes that occur over time (Ritchie and Lewis, 2008).

We have used a set of different data collection techniques, with primary and secondary data triangulation to validate interviews and fill in gaps, as proposed by Denzin (1978):

(1) Document analysis: desk research was carried out to provide data to analyze the contextual characteristics of the case study, including historical, socioeconomic, cultural, and agricultural traits. A review of nature conservancy and biodiversity policy documents (national and regional) was also conducted.

(2) Field research between January and September 2019. All interviews were conducted with more than one of the researchers present to ensure data reliability. Field interviews were conducted with a diverse population in Ilhéus, Southern Bahia, where the analyzed case farmers and stakeholders are located. Additionally, we ran a series of interviews — a mix of in-person and via Zoom app — with professionals involved in the cocoa chain. There were:

(i) In-depth interviews with stakeholders (face-to-face);
(ii) Workshop with producers (face-to-face);
(iii) Direct observation in a visit to Ilhéus region;
(iv) Interviews with producers for data verification via Zoom.

(3) Additionally, we interviewed specialty coffee and wine experts: these sectors have undergone transition processes similar to the ones faced by cocoa. There were three phone interviews, lasting an average of 45 minutes.

(4) Series of webinars with six episodes, run on YouTube, addressing various aspects and information on *cabruca*. The webinars happened between February and June, de 2021.

An unstructured script with some guiding topics was used as a common thread to lead the interviews toward a broader understanding of local conditions and a more precise mapping of involved stakeholders and the relationships among them (Cooper and Schindler, 2003). We transcribed the interviews and coded them to enable the identification of addressed concepts and dimensions in the interviewees' speech. Next, we compared and categorized interviewees' statements in a structured fashion according to the core content. Data analysis was performed based on the conceptual framework laid out in the Theoretical Foundations section and the conceptual model; the analysis is presented in the following sessions. The conceptual framework and data codification are shown in Table 1.

Table 1. Concepts, dimensions and codes

Concept	Dimension	Code
Niche	Technical	N_tec
	Human-social	N_hs
	Institutional	N_inst
Regime	Technical	R_tec
	Human-social	R_hs
	Institutional	R_inst
Landscape	Socioeconomic	P_se
	Biophysical	P_bio
Anchoring	Technological	A_tec
	Network	A_net
	Institutional	A_ins
Sustainability	Economic	S_ec
	Social	S_soc
	Environmental	S_env
Economic upgrade	Product	Up_prod
	Process	Up_proc
	Functional	Up_func
Environmental upgrade		Up_env
Social upgrade		Up_soc

5. Case description

The selected case study was the socio-technical transition experienced by a group of producers in Southern Bahia (Figure 2), who migrated from a regular cocoa cabruca production system to high-quality cocoa production. Said group was constituted of 18 farms, 16 of which were small (20 to 50 ha), all located in Southern Bahia, *cabruca* system cocoa producers, and interested in tailoring part of their output to the premium cocoa market.

Brazil is the seventh largest cocoa producer in the world, bearing 265 thousand tons. The northeast region has 69.7% of the national producing area, but the North region is the leading national producer (53.2%) (Brainer, 2021). Bahia is the only Northeast cocoa-producing state, producing 111,400 tons on 403,000 ha. Up to the late 1980s, Bahia State production neared 400 thousand tons, bringing Brazil to the leading position in the world. Nevertheless, over the 1980s and 1990s, production significantly declined due to international market price reduction (P_se) and, more importantly, due to "witch's broom" propagation, a disease (P_bio) in the Amazon region, which was the greatest threat to cocoa trees, as affected tree parts are not able to perform photosynthesis and release substances that reduce fruit production, making chocolate production unfeasible (CEPLAC; 2015).

The crisis severely damaged the local economy, which had on cocoa its foundation: rural exodus and "slumization" of nearby towns followed (CEPLAC, 2015). Low productivity and unrewarding market prices combination have elevated cocoa farming risk (T) in Bahia, causing some producers to abandon *cabruca* cocoa to adopt other extensive practices or pasture in their properties.[1] Bahia's average production rate is 274 kg/ha, a third of the North region (892 kg/ha) (Brainer, 2021). The world average is 446 kg/ha (FAOSTAT).

[1] Webinar *cabruca*'s facts and perspective. "Cocoa Producers Union President."

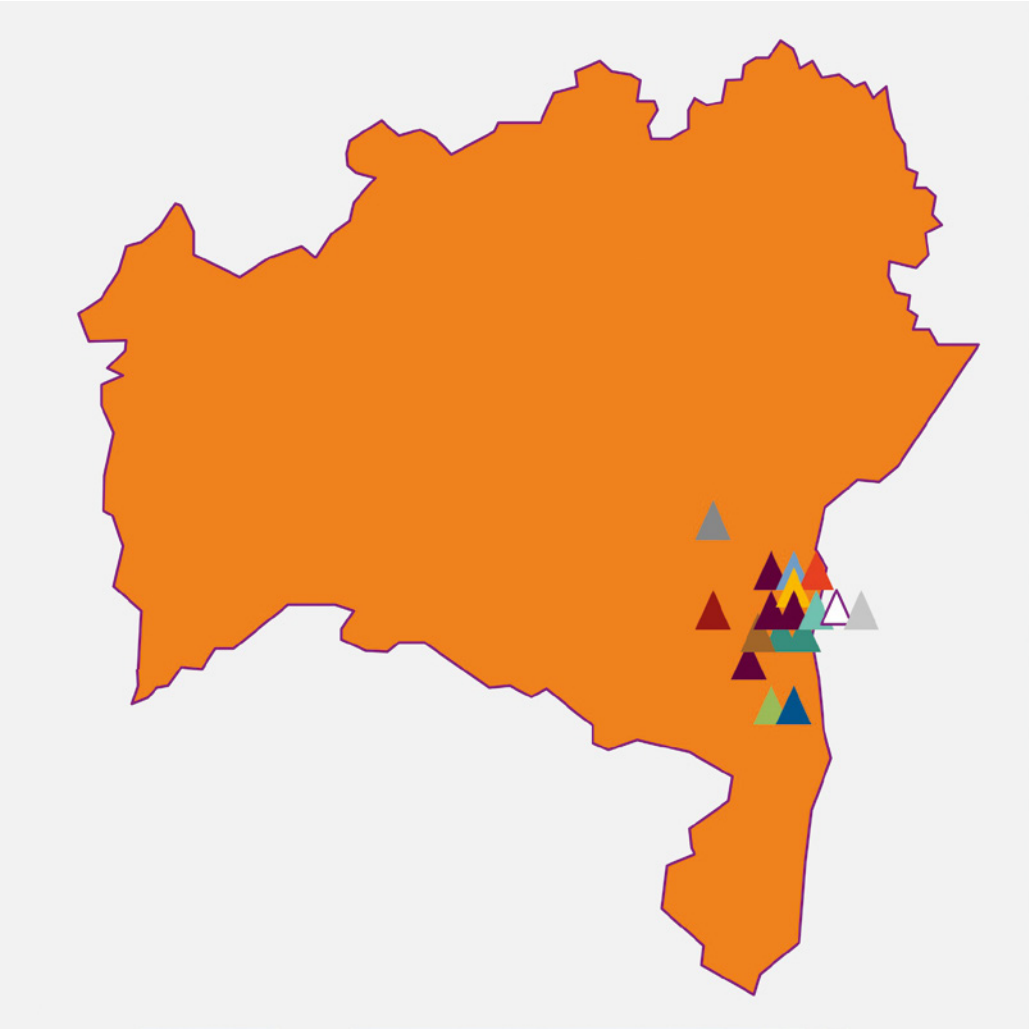

Figure 2. Premium cocoa farms location in Southern Bahia

In this way, a highly environmentally sustainable agroforestry system (S_env) has been replaced by the total deforesting system (intensive culture) due to its low economic and social sustainability (S_ec and S_soc). Facing this scenario, some actors concerned with Atlantic Forest conservancy started looking for sustainable alternatives to prevent this ecosystem degradation. In 2008 one particular actor with great economic power, great passion for Southern Bahia, and direct action on sustainability started an NGO. This organization's objective was to promote discussion and network action for the collective development of sustainability-based solutions. The NGO motivates different actors, pursuing sustainable development and valuing Southern Bahia and Amazon biodiversity potential. They have developed a regional program to turn it into a sustainable development model based on collective work by partners, community, and public authorities.

An opportunity (O) has raised to the cocoa sector with the increase in international demand (P_se) for sustainable products (S_env, S_soc, S_eco), with fair profit distribution throughout the distribution chain (fair trade) and bio, as consumers become willing to pay a premium price for those traits (P_bio and P_se).

Nevertheless, entering the high-quality cocoa production and commercialization market is a complex transition. The cocoa market is divided into four segments: commodity, certified, fine aroma cocoa, and premium cocoa. The higher de nut quality (Up_prod), as assessed by defect reduction (% of moldy, burnt, or

insect-damaged nuts, unfermented, sprouted and flattened kernels), the greater the technical sophistication needed in production (Up_proc), what impact mainly around process innovation, particularly the selection of ripe fruit, careful harvesting, breaking open, controlled fermentation and drying, and separation of defective fruit. Moreover, to be considered fine cocoa, the product must go through an organoleptic and chemical characteristics evaluation (N_tec), comprising original aromas and flavors — like fruity, floral, wood, caramel, and nuts — and constituting aromas (from fresh nuts) and fermenting aroma (Up_func). Notwithstanding, if cocoa is classified as high quality (fine), the price can be three-fold compared to regular cocoa (S_ec) (Equipe …, 2019). However, if this assessment is not performed, cocoa keeps bulk prices according to the Board of Trade prices. Some criteria might be subjective, hindering price estimation and increasing producers' risk. In this context, certifications help producers dodge commodity pricing, as quality may be linked to origin, traceability, and certification (A_ins). An opportunity demanded a technological change (N-tec) and a transition process involving the entire production system.

The range of actors involved in the initial conception and evolution is wide. Farmers, NGOs, municipal and state government agents, researchers, and consultants were there.

6. Results analysis

It has been about six years since the initiative started, which enabled us to analyze two out of three phases of the transition process proposed by Kanger and Schot (2016): niche pre-development and exploration, acceleration, and incorporation. The stabilization phase still needs to be reached.

The proposed conceptual model has worked as an analysis tool for the transition process experienced by the consortium. Different actors and every interrelation between them constituted the system. Field-collected material was abundant and provided appropriate content to analyze.

The Appendix at 10.6084/m9.figshare.25287940 brings a data compilation of the analysis result. The transition has started under the influence of exogenous landscape factors, both bio-physical (P_bio) — as "witch's broom" has reached Southern Bahia — and socioeconomic — the change in consumer preference towards high-quality, sustainable products. As the niche was defined (Nt_1), the transition toward sustainability was triggered. Empirical data demonstrate that the transition process was long, tortuous, not linear, and involved a range of actors. Niche's transition onto different levels in sustainability dimensions, as observed in Figure 1 (from N_1 to N_2), was embedded in technological, institutional, and human-social dimensions, both at niche and regime layers. All dimensions went through changes. Appendix B at 10.6084/m9.figshare.25287940 summarizes the transitions observed in every analyzed dimension.

At the beginning of the transition, an actor with excellent persuasion power was crucial during the niche development phase: this actor set an example to other farmers. This person is a successful entrepreneur who decided to put social, relational, and economic capital accumulated throughout his history to serve a broader societal transformation. This actor has started the transition process in his property, demonstrating that the benefits were concrete, and the transition process was feasible. On top of being an example, he has created an NGO to help systematize experiences and investment, establish connections and networks, and maximize the impact. The NGO has provided technical, economic, and institutional support. That means the niche's human-social dimension was reasonably active, having developed an important support net (N_hs) for premium cocoa production, with knowledge and information exchange, as well as decisive NGO action (N_hs and R_hs) in building professional networks and trust, in a way that future partnerships could be settled, with the goal of obtaining financial gain (Up_prod). There was hard work to convince farmers of *cabruca*'s importance and advantages, its ecological and cultural value (N_inst), and the possibility of future gains. At the same time, in the technological dimension, the niche has also advanced via training (N_tec) on nut and production processes characteristics. As these two dimensions progressed, consequent transformations happened in the institutional dimension, as those training programs started to change how

farmers saw *cabruca*. Producers' view has changed, and they started to value the *cabruca* agroecological system, perceiving its cultural values (N_inst) and economic potential.

When approaching the analysis under a systemic lens, we observe that as transitions occurred in the niche, they spilled over into the regime in the exact dimensions they affected in the niche. That has happened through anchoring processes (A_tec, A_red, A_inst). An example of anchoring: for the transition of the technological dimension to take place in the niche, the NGO brought agronomists, specialists in productive processes, and researchers from the regime to offer assistance and training to farmers (R_tec). Therefore, a transition also happened at the regime level, as professionals improved their capabilities to be able to train niche farmers. For a complex transition process to take place, it is necessary that the regime also is transformed, supporting the niche in its "movement" towards sustainability.

Through those exchanges, both within the niche and between the niche and regime, the transition process advanced in a gradual maturing fashion. Farmers expanded their knowledge of the market and technical needs and challenges, strengthened themselves through the built network, and pursued the changes they needed in the regime. The proof that the regime's transition occurred with the creation 2017 of the Cocoa Innovation Center (CIC). The center's objective is to conduct various cocoa nuts analyses to support market development, bringing together high-quality cocoa buyers and farmers. CIC serves various farm sizes and even the cocoa processing industry. That means the regime dimensions also progressively changed as new actors came into the scenario, needed so the niche could be established, but also working as support to other niches, as they belong to the regime.

As the transition advanced, getting into the acceleration and incorporation phase, more extensive changes happened on the regime level at the institutional dimension. There were changes in the legislation regulating the *cabruca* agroforestry system, political changes bringing more support to high-quality cocoa producers, and government bodies changes — like CEPLAC, which had an autonomy increase and has taken charge of the cocoa five-year strategic plan. On top of that, network actors articulated a movement to show the need for credit lines dedicated to *cabruca* production. Changes in support policies for cocoa producers were vital to increase their chances of reaching the market. Regimes actors have managed to help them in getting the *Rainforest* seal — a sustainability standard related to tropical forest conservation — and the *Indicação Geográfica do Sul da Bahia* (Geographic Indication of Southern Bahia) in recognition to local producers for their environmental sustainability contribution.

The advancement of the niche transition also leads to progress in the regime's human-social dimension, with cooperation among actors, knowledge transmission, and collective learning.

According to Elzen *et al.* (2012), anchoring is about the link between a novelty and existing structures and institutions, meaning anchoring functions as a safety thread while the niche moves towards full sustainability. In this case, we observe anchoring in all three dimensions: technological, network, and institutional. As for the technological dimension, examples of anchoring include CIC creation; the definition of a high-quality cocoa market through well-defined technical aspects; in February 2020, the Agriculture and Agrarian Reform Commission's approval to the project that forecasts higher investment in research to foster production by improving productivity and bean quality aspects. Still, in the technological dimension, anchoring was observed within the niche, as after the consortium contracts signature, a rural extension was offered to participants, aiming at reaching standardization of the sold nuts.

Among the network anchoring aspects, collaboration, cooperation, and learning based on knowledge exchange were significant highlights. Small producers had the opportunity to join a high-quality cocoa sales contract counting on large producers' support, enabling them to progressively increase their high-quality cocoa production. The NGO has acted, being responsible for organizing the group and facilitating the rapport;

CEPLAC functioned to foster and promote cocoa production in Bahia and other states, mainly focusing on quality. Moreover, CEPLAC will encourage cocoa usage expansion beyond the food industry, moving into pharmaceutical, biochemical, and cosmetic segments. The cooperation among actors has created social bonds that led to social capital development. The consortium's formal constitution — through a contract among producers — has enabled the implementation of an action plan for collectively-owned equipment management and the launch of a brand representing and promoting Southern Bahia's high-quality cocoa. Still, on network anchoring, a major highlight was the involvement of actors with strong personalities, essential to cooperation and information exchange activities, particularly at the early stages.

Another key network anchoring example in the niche was formal resource sharing. The top two producers presented opportunities to increase efficiency by offering a low-cost mechanism to obtain resources, such as storage and logistics, to be shared according to production and sales volume — this has helped producers to reduce costs and increase their chances to keep nuts high quality.

Regarding the institutional anchoring instances, there were changes in the legislation over *cabruca* production, enabling productivity to grow, on top of incentive and financing political changes. The *Rainforest* seal and the Geographical Indication of Southern Bahia are worth highlighting, as well as the recognition of Brazil as an exporter of 100% fine aroma cocoa. Another relevant anchoring example was the initiative to promote chocolate consumption in Brazil by introducing it into the school lunch menu.

Throughout the anchoring process between niche and regime, some hybrid actors have been noticed: they were engaged in both regime and niche levels. Those actors were the association, technical networks, NGOs, and the Agriculture Chamber. They may congregate with local representatives, civil society actors and farmers (Elzen *et al.*, 2012).

Empirical data make clear the change in the consortium producers' vision, which saw in *cabruca* the possibility of expanding beyond cocoa and exploring the region's cultural and environmental value, setting goals of fostering ecotourism and promoting *cabruca* into other ecologic-driven segments, such as cosmetic industry.

The social dimension also moved towards sustainability since technically more sophisticated processes demand qualified labor: producers then aim to improve compensation and provide training.

Therefore, empirical data clearly show that the transition process has advanced in all dimensions of MLP analysis. It is also evident in the anchoring processes' relevance.

Considering sustainability, it is definite that the transition process has occurred in all three dimensions. Environmental sustainability has advanced with changes in the legislation that have enabled productivity increase in the *cabruca* system; and the Rainforest seal and Geographical Indication of Southern Bahia, which reward producers for their environmental concerns. In the economic dimension, the product's upgrade had notably made it sustainable, bringing higher profitability to producers than regular cocoa. Moreover, regarding the social dimension, significant progress came from the demand for qualified labor, besides the social gain from the newly allotted value to *cabruca*, the forest, and the region's cultural aspects.

7. Concluding remarks

This work aimed to analyze the process of transitioning towards full sustainability in an agroforestry chain, pinpointing the key factors driving the process. With this aim, the study has proposed a conceptual model based on well-explored concepts presented by MLP and further scrutinized by Elzen *et al.* (2012). The model's goal was not to introduce a new theory but to propose a new way to examine the transition process, inviting the sustainability dimensions.

Content analysis and data triangulation have enabled a great understanding of the process, drivers, and critical success factors for the transition of high-quality cocoa in the Southern Bahia consortium. The studied case evidence that environmental sustainability alone is not enough to guarantee forest conservation is paramount to pay attention to the triad of economic, social, and environmental sustainability to reach a lasting transition.

The studied case was successful in its process of transition towards full sustainability. The cocoa production upgrade to high quality and the producer consortium consolidation resulted in incremental changes at the regime level, thus granting a standing position within the cocoa production system.

Interpersonal relationships played a crucial role in developing concepts and strategies and establishing functional structures. In this sense, cooperation and relationships among actors are vital, especially in the initial and development phases. Later, rules and structure formalization replaced interpersonal relationships, as observed when the consortium became an entity. With that, in the acceleration and incorporation phase — when niche and regime actors frequently apply anchoring mechanisms — cooperation again appears as a critical factor. Generally speaking, cooperation has proved more relevant (i) within the niche at the early stages and (ii) between the niche and regime at the acceleration phase.

Anchoring is crucial for the transition dynamics. By linking the innovation to the regime, anchoring creates "support" mechanisms that pave the way for a long journey. All three anchoring types were present throughout the transition process at niche and regime levels. Anchoring is not a linear process: anchoring sequences ensued in connection to several novelties and interacted, generating new anchoring instances. The study has also identified hybrid actors, who play a crucial role in the anchoring processes and the transition.

The upgrade to high-quality cocoa production has broadly contributed to the Bahia cocoa chain, as niche changes culminated in regime changes. The initiative has strengthened the *cabruca* production value chain, backing various forms of cooperation among farmers and business partners (including knowledge transfer mechanisms), which alter the regional added value chain structure towards greater integration.

Normative institutions and financing opportunities were also identified as key factors to enable transitions. Per MLP, the successful niche innovation transition happens when the socio-technical scenario opens a window of opportunity as it puts pressure on the regime. In the case of hands, the transition was implemented efficiently and shaped by a bottom-up approach through the involvement of relevant stakeholders. This policy-oriented process allows/compels the regime to acknowledge the niche and was promoted by ascending processes mainly driven by the NGO responsible for the consortium consolidation. This NGO was an active advocate of policy requirements and a facilitator of inter-relations between niche and regime actors. Another important lesson learned is the producers' role in cooperation and network processes, as well as its potential effect on the path to transition: farmers, with support from the NGO and other institutions, became initiative leaders capable of influencing government decisions and policymaking.

The study contributes to theory by identifying in the conceptual model the three sustainability dimensions in order to achieve a lasting transition: economic, social, and environmental sustainability. Moreover, the conceptual model introduces the idea of niche displacement towards different combinations of economic, social, and environmental sustainability. It brings a systemic view to MPL by observing the transition occurring in the regime represented by its dimensions, allowing the niche to move as well, according to changes in each MLP dimension. Therefore, the model offers an overview of the dynamics of transitioning toward full sustainability in an agroforestry system.

The study also has practical implications. The proposed conceptual model may function as a niche transition analysis tool. By separately outlining each regime and sustainability dimension, it allows for simulating the impact of various government policies and how they would displace the niche in each dimension. By placing niches in the model at different transition moments, it is possible to infer which measures are necessary to

attain the desired status since the model helps this visualization. The model also could be used as an analysis tool to identify the relative positioning — in regards to sustainability — of different niches within a given regime, helping to set priorities and support policies to move one or more niches towards full sustainability. Additionally, changes in the regime caused by interaction with a niche may be observed as they impact other collectively analyzed niches. Therefore, this model has advancement potential and may serve as a research and simulation tool for sustainability transitions, on top of being able to support the making of public policies that seek to influence sustainability transitions in agricultural chains.

Another contribution to sustainability public policymaking is based on the empirical findings, which evidenced knowledge gathering, cooperation among actors, and information and supported exchanging as crucial factors to trigger the niche transition process. There is, therefore, an avenue for public agents — even in partnership with the private sector — to act in order to spread knowledge on sustainable agricultural practices.

Results also manifest the need to focus on individual actors' roles in the transition process since the identified critical factors for the transition process are specific actors' interests. Elzen *et al.* (2012) highlighted that hybrid actors' presence also seemed relevant in the anchoring process, indicating new research paths.

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