Revista Brasileira de Inovação
ISSN 2178-2822
DOI: https://doi.org/10.20396/rbi.v19i0.8657550

ARTICLE

Niche evolution, external circumstances, and network transformation: from butiá technical niche to butiá socio-technical niche

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Received: 19 November 2019 Revised version: 01 April 2020 Accepted: 13 May 2020

Abstract

This article analyses the impact of external factors on niche evolution and, in particular, the change from a technical niche into a socio-technical niche. When we review the literature on niche evolution, we find that discussions on the impact of external factors on niche evolution are not clear, particularly, on new financial sponsors' expectations. Therefore, this paper attempts to answer the following research question: Do changes in public financial resources contribute to transforming a technical niche into a socio-technical niche? We analysed an agricultural innovation niche case based on Butiá Native Fruits (e.g. Butiá odorata and others species), developed mainly by Temperate Climate Brazilian Agricultural Research Corporation (EMBRAPA) to understand whether and how external factors might contribute to an evolution of a niche. We found that new financial sponsors' expectations can cause an important change in the evolution of a niche. Before the existence of a new external finance sponsor, the technical network niche was composed of research organisations and researchers working on isolated projects. However, after a new external finance sponsor was found, the network or organisations moved into experimental activities, upscaling, and outscaling, and began to incorporate multilevel organisations and people. Consequently, a more complex,

coordinated organisation was created that incorporated social co-production, democracy, and participation, and the niche progressed towards a socio-technical niche.

Keywords | External circumstances; Financial sponsors' expectations; Niche evolution; Niche network transformation

1. Introduction

This article analyses the impact of external factors on niche evolution. The main focus is on whether new financial sponsors expectations can change a niche from a technical niche to a socio-technical niche. A technical niche has been described as a network where the combined efforts of a community are developed through individual projects to generate new knowledge. Niches emerge through a variety of network activities to create and share general knowledge, redefine agendas and visions, and transmit the outcomes of these efforts (GEELS, 2002; FONTES; SOUSA; FERREIRA, 2016). Socio-technical niches, by contrast, imply co-production of social, behavioural, and technological change in an interrelated way (SCHOT; STEINMUELLER, 2018). This, therefore, involves radical change in all elements of the configuration and also implies network creation that increases democracy and citizenship participation (SCHOT; STEINMUELLER, 2018).

Niche evolution has been conceptualised as having a non-linear trajectory along which an emerging network is structured through a socio-cognitive process. Geels and Raven (2006) demonstrated that the main factors that create changes in technical niches are shared positive expectation of new technology and shared cognitive rules. Shared cognitive rules represent stocks of knowledge from previous experience, guiding perceptions, and interpretations. Expectations are a particular set of cognitive rules that are oriented to the future and related to action in the sense that they give directions to research and development activities (GEELS; RAVEN, 2006). Both these factors are influenced by sponsors that provide necessary resources for these projects, mainly funding and other resources, such as infrastructure and organisational support. Once the sponsor agrees, then a protected space network where search and development activities take place is created.

In niche literature, a protected space means a shielded, nurtured and empowered space (SMITH; RAVEN, 2012). Smith and Raven (2012) explained that shielding

involves putting in place processes that hold off selection pressures in the context of multi-dimensional selection environments, such as industry structures, technologies and infrastructure, knowledge bases, markets and dominant user practices, public policies and political power, and cultural significance. Nurturing involves setting up processes that support the development of path-breaking innovation within passive and active shielded spaces through the development of shared, positive expectations; social learning; and active network building or the development of system structures and functions. Empowering involves creating processes that make niche innovations competitive within unchanged selection environments (fit and conform), or processes that change mainstream selection environments favourable to the path-breaking innovation (stretch-and-transform). In synthesis, Geels and Raven (2006) emphasised that niche evolution is guided by shared cognitive rules and expectations. However, they emphasised much more change from internal expectations than external expectations, which may come from changes in external circumstances such as different external financial sponsor expectations (KÖHLER *et al*., 2019; SCHOT; GEELS, 2008). It is therefore not clear whether and how external factors might contribute to niche evolution, particularly from a technical niche to socio-technical niche (KÖHLER *et al*., 2019; SCHOT; GEELS, 2008). To be clearer about whether and how external circumstances might contribute to changing niche evolution, Bergek *et al*. (2015) proposed four kinds of interactions between a niche and context: technological, sectorial, geographical, and political. Bergek *et al*. (2015) proposed that a change in the political context might be explained, for example, by a lack of change in the availability of public financial resources for research.

Therefore, the main theoretical questions emerge: Do changes in public financial resources contribute to evolution from a technical niche into a socio-technical niche? The paper's objective is to bring new empirical evidence to determine if financial sponsors are relevant in transforming a technical niche into a socio-technical niche in developing countries. We build on literature related to the evolution of technical and socio-technical niches (GEELS; RAVEN, 2006; JOLLY; RAVEN, 2016; SCHOT; STEINMUELLER, 2018) to understand each niche evolution and their main characteristics (HANSEN *et al*., 2017; HERMANS *et al*., 2013; JAIN; HOPPE; BRESSERS, 2017; KUHLMANN; STEGMAIER; KONRAD, 2019).

We analyse an agricultural innovation niche, the Butiá Native Fruits collaboration network (e.g. Butiá odorata and other species), which has been developing mainly by Temperate Climate the Brazilian Agricultural Research Corporation (EMBRAPA)

which is trying to change green revolution logic in a radical way. We combined two data collection methods: open interviews that collected descriptions of niche evolution and documents to complement these interviews. From these, we could identify critical changes in financial sponsors, expectations, actors, and roles along the evolution of the niche. To complement the interviews, we collected data from 65 articles, which were analysed using Social Network Analysis (SNA). It allowed us to understand if there were structural differences along the niche-evolution trajectory.

The Butiá Native Fruits niche tries to introduce more sustainable practices and products (BARBIERI in press) by the collection and use of native Butiás through conservation of natives forests, local food, crafts and culture (MARCHI *et al.*, 2018), against the green revolution logic. The last has implied global problems such as, genetic selection, monoculture, fertilizers, soil erosion, water contamination (FOLEY et al., 2005), contamination of food and people (SOUZA FILHO, 2001), and climate change (IPCC, 2007). Moreover, at present, the main strategy is the creation of social networks composed of small producers, non-governmental organisations, governmental research and support organisations to increase decentralised income generation and to avoid biodiversity reduction and the concentration of power in the hand of a few actors.

The Butiá Native Fruits niche was chosen because it has changed from a technical niche to a socio-technical niche. Butiá's technical niche was created in 2005 when the Research Support Foundation of Rio Grande do Sul State approved the first project. However, a second phase of the niche was initiated when the Ministry of the Environment supported the third project ('The Route of the Butiazais', from 2015 to 2017). The project began receiving resources from the World Bank, but the World Bank insisted that the project incorporate social participation in the technical niche. Thus from 2015, what had been primarily a technical niche (focused on scientific experimentation), grew significantly but with the inclusion of social participation and exchange of knowledge, beyond the proposal of public policies and even community action.

The contribution of the study is in two areas. First, to determine if external forces, particularly, a change in the availability of public financial resources, could contribute to the evolution of a niche through patterns of composition and structure of the network. Second, to explain the change in collaborations patterns on composition and structure of networks when availability of public financial resources change (CANIELS; ROMIJN, 2008; FONTES; SOUSA; FERREIRA, 2016; HERMANS *et al.*, 2017; HERMANS *et al.*, 2013; LOPOLITO; MORONE; SISTO, 2011).

2. Niche evolution and external circumstances: from a technical to a socio-technical niche

A technical niche network is created when new research projects are submitted. New projects might come from a new technological opportunity which is generated externally or from previous work. The protagonists of these new projects, such as public and private research organisations, formulate promises and create expectations about future performance and functionality. At this time, network process formation takes place to support and nurture the changes required. The expectations are then translated into a new niche network with goals, specifications, requirements, and task divisions. Once the projects are ready, it is necessary to try to attract the attention of sponsors who provide essential resources, like money and other resources, for these projects. Once the sponsor agrees, a protected space network, where research and development activities take place, is created (GEELS; RAVEN, 2006).

In a technical niche, task division include experiments. The experimental process includes pilot projects and projects with a demonstration of new technologies (GEELS; RAVEN, 2006). With the experimental process in technical niches, positive evaluations may lead to more complex and ambitious projects. If projects outcomes are positive, a new development cycle is started. Technical models, problem agendas, and heuristics' search may be made more specific, parameters can be refined, and user preferences may be better articulated. Such developments down the design hierarchy give rise to incremental adjustments along trajectories (GEELS; RAVEN, 2006).

Further, positive outcomes can improve prospects for new technology and can attract attention (GEELS; RAVEN, 2006; JAIN; HOPPE; BRESSERS, 2017), and thus, an increasing number of participants who share the same expectations can converge towards a shared vision. Positive outcomes also make it easier to enrol new actors, and expand the researchers and organisational network, resulting in more resources for new projects (GEELS; RAVEN, 2006). It may cause the niche to grow, including more actors and organisations. However, if the network continues to grow, face-to-face contact becomes more difficult and a growing network can easily suffer from a decline of trust between the people involved. This line of reasoning follows (GRANOVETTER, 1985; HERMANS *et al.*, 2013) that of those who argue that closed networks facilitate the effective enforcement of sanctions as all the actors are connected and therefore know each other's actions; a denser network will, therefore,

induce more trust (HERMANS *et al*., 2013). After a network has reached a certain size, actors lose the overview of the whole network and the trust between its members is likely to drop (HERMANS *et al*., 2013). As an alternative to network increase, the network may organise the installation of a central coordinating organisation, which may take the form of a special platform or a consortium that coordinates interactions in the network (HEAD, 2008; HERMANS *et al*., 2013).

However, if project outcomes are negative, then expectations decline, and this is followed by the diminishing of social networks and the drying up of resources. In response to these adverse outcomes, actors tend to engage in repair work and come up with new expectations that promise better results for search heuristics in other directions. If these redirected promises find their way into the agenda of the field, then non-linearity occurs and the innovation journey changes course (GEELS; RAVEN, 2006), which can favour creation of a new kind of niche.

Furthermore, negative expectations that lack enough financial resources to support the network activity are a factor which might change the innovation journey course (AGOSTINO; ARNABOLDI; DAL MOLIN, 2017). In this context, it might be necessary to have a new institutional alignment to create good expectations about future performance and functionality for a new financial sponsor (BERGEK *et al*., 2015) who might support a technical niche's transformation into a socio-technical niche (JOLLY; RAVEN, 2016). Beyond the World Bank, which is cited as a financial sponsor (Introduction)that supports socio-technical niches, other multilateral institutions, such as, for example, the European Commission's (2020) Horizon 2020 project, and the United Nations (NATIONS UNITED, 2020 are funded financial agencies that have mandatory social participation for research funding that is sometimes contrary to the logic of the green revolution.

A socio-technical niche has less focus on R&D and more on network-wide transformations (SCHOT; STEINMUELLER, 2016). Bui *et al*. (2016) identify three key stages in a socio-technical niche evolution: the emergence of the initiative (Stage I); the construction of a socio-technical niche through the enrolment of new stakeholders into the initiative, leading to the diversification of objectives and activities (Stage II); and the construction of an alternative model, impacting various components of the agri-food regime (Stage III).

The emergence of the initiative (Stage I) creates a specific focus and includes a limited range of actors, mainly individuals from a single social group or stakeholders traditionally in charge of the issue (BUI *et al*., 2016). During the construction of a socio-technical niche (Stage II), these individuals or organisations gradually

realise, as they implement their action, that the issue they want to tackle is related to the way various actors are coordinated, and that to have a greater impact, their actions need to be complemented with further changes in the agri-food system. This leads them to widen the circle of actors involved and to try to enrol new actors. As a result, they create a multi-actor organisation for various actors to voice and discuss their viewpoints (BUI *et al.*, 2016). It demands the need to open up the process of choice to all stakeholders including marginalised actors, to provide them with a voice and influence over what paths are followed in the research and its funding (SCHOT; STEINMUELLER, 2018). Socio-technical networks might join organisations across administrative levels, which can lead to institutionalisation of innovation through upscaling and outscaling (HERMANS *et al.*, 2013). Upscaling and outscaling need to happen because transformative change demands a change of lifestyle, and thus the daily use of mobility, water, energy, food, and other resources involves the adoption of practices, not only of individual users (or consumers) but also of industrial and professional users. In the end, change is not only about the construction of new production structures, but also about user environments and markets in which new type of demands and user preferences will be dominant (SCHOT; STEINMUELLER, 2018).

The construction of an alternative model implies exercising interdependencies and contingencies in a non-finalizing way, for example, involving trial and error or the learning process in general (KUHLMANN; STEGMAIER; KONRAD, 2019). It should focus on the search process, guided by social and environmental objectives, informed by experience and the learning that accompanies that experience, and driven by a willingness to revisit existing arrangements to de-routinise them so as to address societal challenges (SCHOT; STEINMUELLER, 2016).

Alternative models should challenge incumbent firms and governments to grapple with the new socio-technical goal. During this process, the role of intermediary actors in advocating competitive niches, new visions, and policies is crucial, and the socio-technical niche should grow to embrace both niche actors and dominant regime actors (SCHOT; STEINMUELLER, 2018). Thereafter, stakeholders create decision-making processes that change the direction in which a field develops. It happens, for instance, by re-shaping the socio-political legitimacy of the socio-technical niche through media exposure, or agreeing on new industry standards, or deriving policy lessons that are picked up in political debates which inform of new regulations or support incentives that might contribute to upscaling and outscaling actions (HESS; YEUNG, 2006; JOLLY; RAVEN, 2016).

3. Methods

In order to address the main theoretical question about whether a change in public financial resources might transform a technical niche into a socio-technical niche, we developed a case study (YIN, 2009) on an agricultural innovation niche, Butiá Native Fruits, in the south of Brazil, which is led by EMBRAPA. To carry out this case study we used mixed methods, i.e. both qualitative and quantitative (CRESWELL; CLARK, 2011), to address the primary research question: Does a change in public financial resources contribute to transforming a technical niche into a socio-technical niche?

In order to answer the research question, we proceeded with two kinds of data collection: open interviews (Table 1) and SNA. The objective of the open interviews was to understand how a niche evolved. The questions that guided the data collection were: How did the niche of Butiá Native Fruits emerge and evolve at EMBRAPA? Besides this, four other complementary questions were asked: What was the initial role of the government and research organisations and how did they play a part in the development of the niche? What changes occurred in quantity (size) and diversity (composition) of network actors? Is it possible to identify intermediaries from other actors of the current regime? What is the spatial scale of the actors in the network? The interviews were recorded and transcribed in order to identify the empirical foundations of the Butiazal niche evolution.

Besides this, more than 30 documents (projects, research reports, photos, web sites) were analysed, with two being the principal documents: 1) Barbieri (in press). *Route Butiazais Research Report*. 2) Brasil (2018)—Environmental Ministry of Brazil. *Nacional Project for Integrate Action Between Public and Private Organisations for Biodiversity*—Probio II, 2018.[1]

After analysing the interviews and documents, it was necessary to combine the various perceptions about the critical changes in financial sponsors, expectations, actors, and roles in order to create a reliable interpretation about the evolution of the niche (YIN, 2009). The interviews and documents supported the understanding of the niche's evolution and provide a timeline for the projects, actors and roles, changes in network structure, changes in expectations, and shared cognitive rules.

1 The photos and web sites databased can be accessed at https://1drv.ms/u/s!AvR6QubocHClhLVFgRKZD7ZDR5CeQQ?e=ioKqLv

TABLE 1
Researchers interviewed about the butiá niche of native fruits

Interviewee	Qualifications	Working at EMBRAPA
1	Graduated in Agronomy— UFPel Master of Horticulture—University of Arkansas PhD in Plant Science—University of Arkansas	From 1974 to date
2	Graduated in Food Technology—UFSC Master of Agroindustrial Science and Technology—UFPel PhD in Agroindustrial Science and Technology—UFPel	From 2002 to date
3	Graduated in Agronomy—UFSM Master of Agronomy—UFPel PhD in Horticulture Science—Texas A & M University	From 2006 date
4	Graduated in Agronomy—UFSC Master of Agronomy—UFPel PhD in Agronomy—UFPel	From 2008 to date
5	Graduated in Biological Sciences—UCS Master of Genetics and Molecular Biology—UFRGS PhD in Genetics and Molecular Biology—UFRGS	From 2002 to date

Source: prepared by the authors (2020)

We then proceeded with the SNA of 65 pieces of academic communication (theses, articles, etc.) to know who were participating inside the niche and who were related to each other through the authorship and co-authorship of each of these academic communications. These were used because the authorship and co-authorship represented those who were involved in academic research. Besides this, the SNA was mainly used to identify the relationships in the construction of scientific knowledge (MARTELETO, 2001; ROSSONI; GUARIDO FILHO, 2009; SCOPONI *et al.*, 2016). These 65 academic communications were collected from EMBRAPA's library. We used 'Butiá' as a key word to identify these academic communications.[2]

Data processing was carried out to obtain the structural measures, and the elaboration of the graphs was done through the software UCINET 6 and the application NetDraw that is part of that package (BORGATTI; EVERETT; FREEMAN, 2002). The papers' authors and co-authors were considered network nodes. Ties were defined as the relationship between authors and co-authors.

SNA is a theoretical and methodological paradigm to analyse social systems using a structural approach (AHUJA; SODA; ZAHEER, 2012). It analyses social relationships, considering, on the one hand, if they determine specific social structures

2 A list these 65 academic communications can be accessed at https://1drv.ms/w/s!AvR6QubocHClhcJxF4BNaFsrN6zmqA?e=dekR2O

and, on the other, if they make up the network of relationships that in turn restricts actors' behaviours. A social network is a series of links among a defined set of social actors (individuals, groups, organisations, countries, etc.). Therefore, these links as a whole have the property of providing interpretations of the social behaviour of the actors involved in the network.

An analysis of the network size, density, degree centralisation, and average distance was carried out to understand if there were structural differences between the technical niche network and the socio-technical niche network (AHUJA; SODA; ZAHEER, 2012; WASSERMAN; FAUST, 1994).[3]

The size of a network is the total number of nodes that it is composed of (Equation I), a measure that reflects the magnitude of the studied environment (WASSERMAN; FAUST, 1994).

$$T = \sum_{j=1}^{T} g_j$$

Equation I

The density of a network is the proportion of possible lines that are present in it (Equation II). It represents the ratio between the present number of lines (L) and the maximum possible lines (g (g-1) / 2). It is denoted by the letter Δ and its value is established in the interval [0, 1]. The density expression expresses the degree of linkage between the actors in a network, demonstrating the relationship between the number of ties actually made over the feasible total (WASSERMAN; FAUST, 1994). When many possibilities for relationships are absent, weak ties are formed between the actors, indicating a low network density. On the other hand, the presence of many possibilities for connections indicates a consistency and proximity between the actors, making them densely connected and with corresponding strong ties (GRANOVETTER, 1973; TOMAÉL; MARTELETO, 2007; MARTINS, 2009).

$$\Delta = \frac{2L}{g(g-1)}$$

Equation II

3 Databases can be accessed at https://1drv.ms/u/s!AvR6QubocHClhb56UTOgzwGVkmxKsg?e=lhiUp0

The degree centrality of a node is the number of nodes Pj ($i \neq j$) that are adjacent to it and with which it is in direct contact (FREEMAN, 1979). It varies between 0 and (T-1), where T is the number of nodes (Equation III). The node with degree 0 is called an island (FREEMAN, 1979). Actors with greater degree centrality have more ties and, consequently, greater opportunities, because they have more options. This autonomy makes them less dependent on any other specific actor and therefore more powerful. In addition, since they have many links, they can access and get more of all the network resources. The degree centrality identifies the number of direct or adjacent contacts that an actor maintains in a network; it measures their level of communication and enables an assessment of the local activity of the actors (HANNEMAN; RIDDLE, 2005; ROSSONI; GUARIDO FILHO, 2009).

$$d = \frac{\sum_{i=1}^{g} d(n_i)}{g} = \frac{2L}{g}$$

Equation III

The average geodetic distance gives an indication of the degree of distance between the nodes (on average) (WASSERMAN; FAUST, 1994). The formula for calculating this metric is shown below (Equation IV).

$$l = \frac{1}{(\frac{1}{2})n(n-1)} \sum_{i>j}^{g} d(i,j)$$

Equation IV

4. Butiá native fruit niche evolution: results and analysis

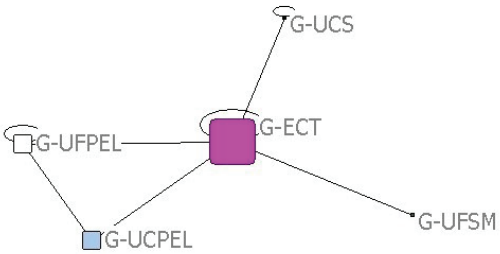
Until the 1960s, Butiá was a considerable source of income in the south of Brazil. The fibrous leaves were used to make mattresses, and many farm producers were suppliers. There were several companies which prepared fibrous leaves from butiás in Santa Catarina and the Parana e the Rio Grande do Sul states (South of Brazil). They were essential suppliers for companies located in the cities of São Paulo and Rio de Janeiro (more important cities in Brazil). Other countries like Uruguay, Argentina, and Paraguay have Butiá species, and in the past, they had several mattress companies too (BARBIERI, in press).

However, mattress technology changed, and this activity went bankrupt. Consequently, native butiazais were replaced by rice in the 70s and 80s (in the Rio Grande do Sul and Santa Catarina States) and have been replaced by soya bean today (in the Rio Grande do Sul State) (BARBIERI, in press).

The deforestation and income concentration in rural areas motivated the EMBRAPA to research new options to Butiá Native Fruits. Thereafter, the Butiá Native Fruits technical niche was created in 2005 when the Foundation for Research Support in the Rio Grande do Sul (1º Procoretes FAPERGS) supported the first project which was nominated as 'Insertion of Native Fruit Species from the South of Brazil in the Agricultural Matrix'. This first project was carried out from 2005 to 2007 (Interviewees 1,2,3,4,5).

The five organisations that participated in the organisation network in 2005 and 2006 were all universities (Figure 1), except for the EMBRAPA. The universities which participated were the Federal University of Pelotas (UFPel), the Catholic University (UCPEL), the University of Caxias do Sul (UCS), and the Federal University of Santa Maria (UFSM).

FIGURE 1
Butiá Technical Niche Research Organisations Network from 2005 to 2006



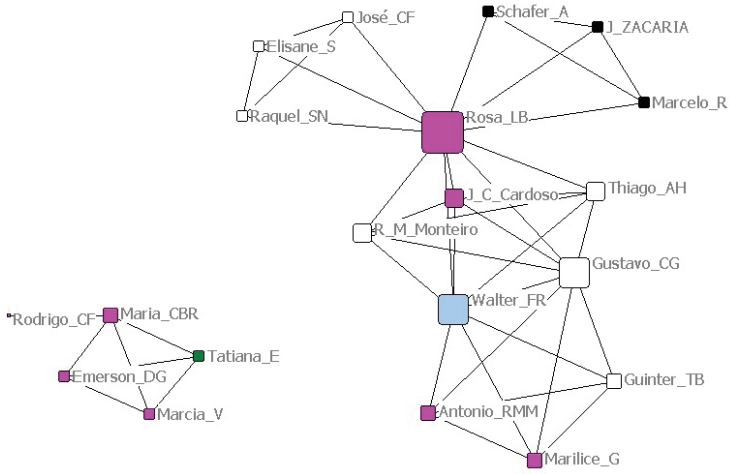
Source: Elaborated from scientific publications by UCINET software.

In addition, there were two researcher clusters (Figure 2). The main researcher clusters were composed of fifteen researchers, and the smaller researcher network was composed of four researchers. The most central researcher was Rosa Lia from the EMBRAPA. These two researcher clusters featured twenty researchers, a density of 0.226, a degree decentralisation of 0.392, and an average distance of 1.783.

When we analysed the initial period of the process of evolution of the Butiá Native Fruits Niche (from 2005 to 2006), we identified a task division in the process of experimentation, which included pilot projects and projects that demonstrated

new technologies. Five universities contributed to conducting the experiments in association with the EMBRAPA, each maintaining its organisational identity (GEELS; RAVEN, 2006). Outscaling and upscaling process activities were not observed in the investigators' reports and interviews (JOLLY; RAVEN, 2016). The process of experimentation was dominant in this period, which characterises the technical niche classification (GEELS; RAVEN, 2006).

FIGURE 2
Butiá Technical Niche Researcher Network from 2005 to 2006



Source: Elaborated from scientific publications by UCINET software.

At the end of 2006, the researchers undertook a project assessment. They concluded that though the project was well-conducted, and good results were achieved, the initial objectives were very ambitious. They would need to be refined, and be more realistic (Interviewee 5).

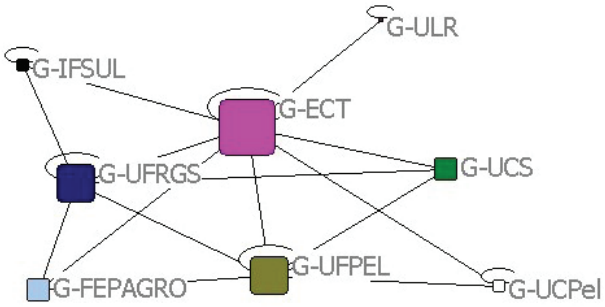
> *[...] we concluded the project at the deadline, and with all the objectives reached. [...]. However, we noticed that the first project was too ambitious. We generated good research results, but it was very ambitious to insert the Butiás Native Fruit in the agricultural matrix [...] (Interviewee 5).*

Between 2007 and 2009 a new project was supported by the Foundation for Research Support in the Rio Grande do Sul (2º Procoretes FAPERGS). It was named 'Conservation and sustainable use of native fruit biodiversity in Southern

of Brazil'. This project was concluded in 2009 (Interviewees 1,3,5). Between 2010 and 2013, the same project was supported by EMBRAPA.

In addition to organisations who participated in the Butiá Technical Niche Network between 2005 and 2006, four more organisations were added to the technical niche between 2007 and 2013 (Figure 3). They were the Federal University of Rio Grande do Sul (UFRGS), the Federal Institute from South of Brazil (IFSUL), one research organisation from the Regional Agricultural Innovation System called the State Agricultural Research Foundation (FEPAGRO), and one international university known as the University of Uruguay Republic (ULR). However, the Federal University of Santa Maria (UFSM) left the organisation network.

FIGURE 3
Butiá Technical Niche Research Organisations Network between 2007 and 2013



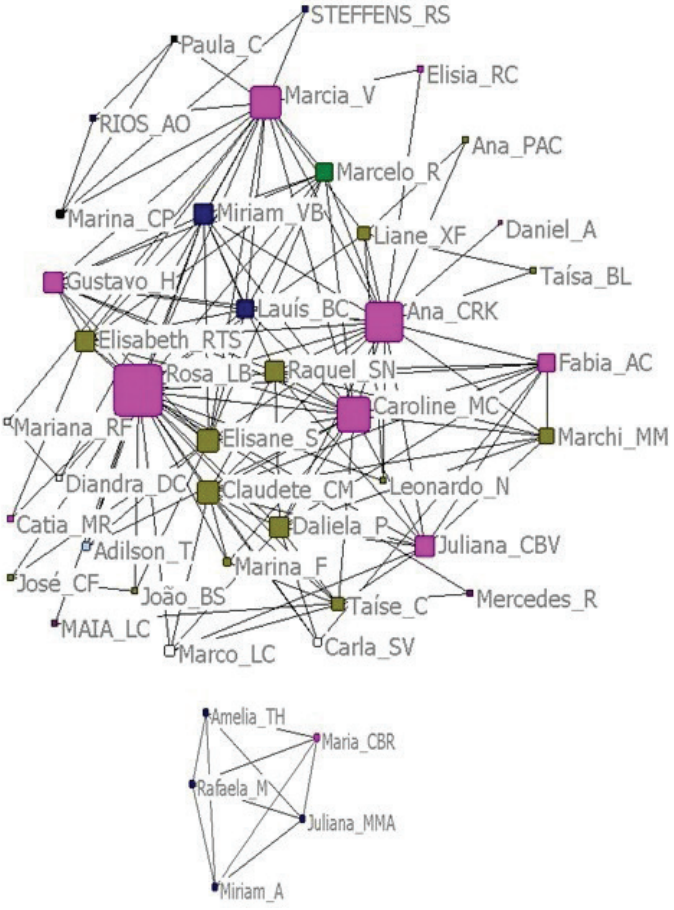
Source: Elaborated from scientific publications by UCINET software.

In the same period, two additional researcher clusters were identified (Figure 4). Both researcher clusters were found to be denser when compared to researcher clusters from 2005 to 2006. The main researcher network was a cluster of 43 researchers, and the smaller researcher network was composed of five researchers. The most central researcher remained Rosa Lia from the EMBRAPA. These two researcher networks were characterised by 48 researchers, with a lower density (0.163), a higher degree centralisation (0.528), and a higher average distance (1.994) than the previous one.

When we analysed this second period of the process of evolution of the Butiá Native Fruits Niche (2007–2013), we verified that the cycle started between 2005 and 2006 and was renewed in 2007. It happened through the approval of financial resources for the new project, and after that, it was supported by the EMBRAPA. The new proposal was adapted, and considered more realistic objectives (Interviewee

3). This positive evaluation and the adjustments favoured the addition of four more organisations (Figure 3), among them, the national and international universities and organisations from the Regional Agricultural System of Innovation. The number of researchers involved also increased from 19 (Figure 2) to 48 (Figure 4). These results confirm what Geels and Raven (2006) and Jain, Hoppe and Bressers (2017) describe as results after a positive project assessment.

FIGURE 4
Butiá Technical Niche Researcher Network between 2007 and 2013



Source: Elaborated from scientific publications by UCINET software.

In 2014, financial resources to support research projects were scarce in Brazil, mainly because the Brazilian Government had suffered a substantial reduction in its budget (Interviewee 2). Then, the organisations that needed research support started receiving financial support from the World Bank, but the World Bank insisted on social participation (Interviewees 1,3,5). The new project had to include stakeholders to discuss and to decide on: 1) the consolidation of existing information on Butias deforestation; 2) the building of a consensus with stakeholders on the analysis of problems and the best solutions; 3) the development of chosen solutions through participatory methods and procedures; and 4) the implementation of the chosen solutions. These requirements aimed to unify strategies that addressed the need for prioritisation and integration of conservation, and the sustainable use of biodiversity, which was supported by relevant stakeholders. These stakeholders would be leaders in economic sectors, agents who intend to add value to productive chains, agglomerates and improve productive arrangements and products (BRASIL, 2018).

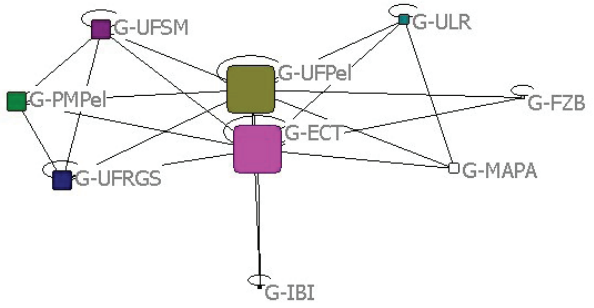
The Butiá Native Fruits Technical Niche followed a particular way to keep working on their research. However, there was a different requirement from the World Bank, which required more social participation. Butiá Native Fruit Technical Niche changed its project, and the EMBRAPA researchers submitted it to the Brazilian Environmental Ministry (Pró Bio 2 - Financial resources from the World Bank), which decided to support the project (Interviewees 3,5). The project was named 'Butiazais' Route' and it would be supported from 2014 to 2017. At the end of 2017, 'Butiazais' Route' received a positive assessment. Then, one more new project (2017–2020) was supported by the National Council for Scientific and Technological Development (CNPq) through the World Bank's financial resources. Again, the World Bank required social participation (Interviewees 1,3,5).

'Butiazais' Route' aimed not only for the growth of scientific knowledge, but also for the growth of learning and culture. The first main strategy for social inclusion in 'Butiazais' Route' was the carrying of open events. It was also used for the discussion and solving of problems associated with productive activities and environmental protection. The second main strategy for social inclusion was the social media network. Public prosecutors, technicians, and representatives from the environmental agency, as well as farmers, collectors, and NGOs participated in the social media network (Interviewee 5).

Between 2014 and 2017, the Butiá Socio-Technical Niche Network (Figure 5) had ties with eight organisations. However, some qualitative differences took place with the composition of the Butiá Technical Niche Organizations Network.

Organisations such as the Zoo Botanical Foundation, the Municipal Government of Pelotas and the Agricultural Ministry were introduced, which are organisations which can contribute to upscaling and outscaling activities. However, research organisations such as the Biodiversity International Institute State Agricultural Research Foundation (FEPAGRO), the Federal Institute from South of Brazil (IFSUL), and the Catholic University (UCPEL) left the Butiá Technical Niche Research Organisations Network.

FIGURE 5
Butiá Technical Niche Research Organisations Network between 2014 and 2018



Source: Elaborated from scientific publications by UCINET software.

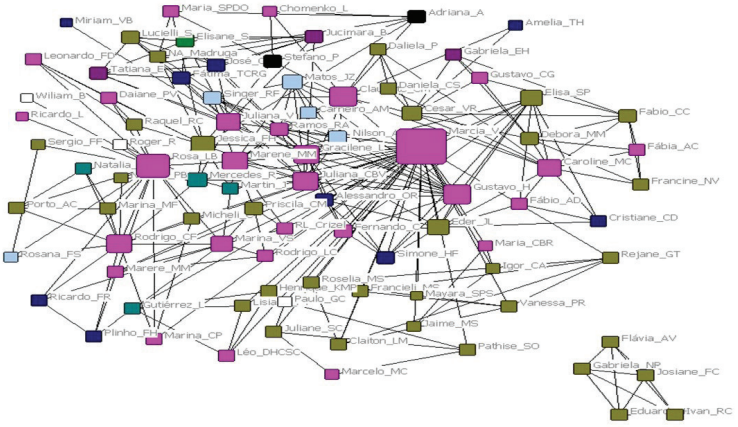
Between 2014 and 2018, two researcher clusters were kept (Figure 6). Both clusters increased in size. The main researcher clusters were composed of 85 researchers, and the smaller researcher network was composed of five researchers. The most central researcher was Marcia Visoto from the EMBRAPA. These research networks grew, and they were characterised by 90 researchers, a lower density (0.069), a higher degree decentralisation (0.355), and a higher average distance (2.794).

When we analysed the evolution of researcher network centrality between 2005 and 2018, we found that the centrality of the researcher network grew from 0.392 for the period 2005–2006 to 0.528 for the period 2007–2013, when the niche maintained technical niche characteristics. For the same periods (2005–2006 and 2007–2013), the EMBRAPA remained the most central organisation, from which it can be inferred that higher centrality of influential organisations within the network increases the power of agenda setting and institutional entrepreneurship (HERMANS *et al.*, 2017).

However, with the requirement of the World Bank of the stakeholder's inclusion inside the niche (2014), we observed that centralisation decreased from 0.528

(between 2007 and 2013) to 0.355 (between 2014 and 2018), from which it can be inferred that lower centrality within the network increases major organization participation on agenda setting and institutional entrepreneurship (HERMANS *et al.*, 2017). With these findings, it is confirmed that the network structure of a technical niche is increasingly centralised (HEAD, 2008; HERMANS *et al.*, 2013). However, with the change in the organisation of the niche from technical to socio-technical, the degree of centralisation of the network declines.

FIGURE 6
Butiá Technical Niche Researcher Network between 2014 and 2018



Source: Elaborated from scientific publications by UCINET software.

With the World Bank requirement for the stakeholder's inclusion inside the niche (2014), we observed that the researcher network size increased from 19 (between 2005 and 2016) to 90 (between 2014 and 2018). Further, network density decreased from 0.226 (between 2005 and 2016) to 0.069 (between 2014 and 2018), and average distance increased from 1.783 (between 2005 and 2016) to 2.794 (between 2014 and 2018). These results are in opposition to successful information exchange because dense collaborative networks facilitate the exchange and dissemination of information (HERMANS *et al.* 2017). Between 2014 and 2018, a new network was structured for the integration of stakeholders in the niche. In this new social network, there were more than 30 new organisations from among city governments, NGOs, the Environmental Inspection Agency, solidarity producers' networks, producers, etc. (BARBIERI, in press).

One main action was organised to boost the interactivity of the social network. This was the creation of learning events for the participation of social actors. These events include discussions between participants about the problems in the Butiá social system and particularly, an experiences exchange between stakeholders (Interviewee 5).

> *[...] We have already promoted five meetings, including one international meeting. The Butiazais Congress is the international meeting of the Route of Butiazais. We organised one in Argentina two years ago, and the next one will be in Pelotas. The regional butiá meeting is organised for our local team. The first regional butiá event was held in 2013. (Interviewee 5).*

These regional and international meetings had organised courses about food preparation, crafts, and technical knowledge. In addition, there was a discussion about the Butiá social system, and action planning and implementation. These implementation actions were supported by one social network which was created to support multilevel actors along with preparation action (Interviewees 3 and 5).

> *Because meetings are exchanges. We learn from them, they learn from us [...]we put everyone in touch with each other. [...] The meeting focus is on the diversity of actors. [...] For example, the Santa Vitória artisans were certified as collectors. They will not incur a fine or a prison term. [...] They went into specific legislation. So, if they get caught carrying butiá bunches in their car, they do not pay a fine. […] Although the registration process was evaluated as an easy process by governmental organisations, the collector expressed difficulties in carrying out the procedure. It happens because it involves the use of computers and it is not always accessible to these people because of their low education level. Then, the network provides support to boost the connection between stakeholders. This was one activity that contributed to the adoption of the practices shared in the events (Interviewee 5).*

When we observe the inclusion of social actors at different levels from socio-technical production systems as producers, government, NGOs etc., and their engagement in a complex organisation that sets learning actions activities, problem elaboration, and problem-solving at events (JOLLY; RAVEN, 2016), we can infer that it will contribute to the upscaling and outscaling of innovation processes (HERMANS *et al.*, 2013; SCHOT; STEINMUELLER, 2018).

On the other hand, although the niche actors worked to overcome institutional barriers related to formal rules (specific legislation) for the upscaling process, we

found that they had more significant difficulties in the adoption of non-formal rules (new practices and shared visions) for which dissemination cooperation in the network was crucial (HANSEN *et al.*, 2018; WIECZOREK, 2018).

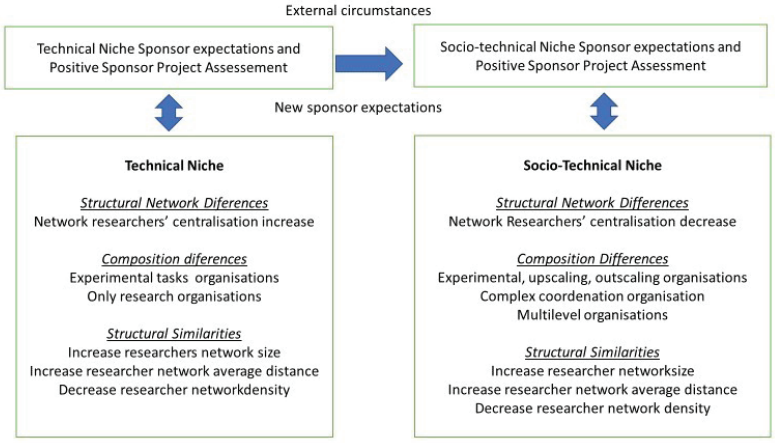
5. Final considerations

This study's main objective was to analyse if financial sponsors might change a niche from a technical one into a socio-technical one. After the analysis and discussion of the Butiá Niche case which was led by the EMBRAPA in the south of Brazil, we came to the following conclusions:

External niche circumstances, through new financial sponsor's expectations, made a change in a niche network's evolution (Figure 7). It was the trigger which changed a technical niche to a socio-technical niche in terms of structure and network composition. Before the entry of a new external finance sponsor, the technical network niche was composed of research organisations and researchers. In addition, the researchers' network had become centralised.

However, after the entry of a new external finance sponsor, the network was composed of experimental, upscaling and outscaling, and multilevel organisations, and a complexly coordinated organisation was created. We may infer that the Butias niche had been improved through social co-production, democracy, and participation inside the niche.

FIGURE 7



Source: elaborated by authors (2020)

These observed results confirmed that when there is a lack of resources (AGOSTINO; ARNABOLDI; DAL MOLIN, 2017) and projects receive a negative assessment (for having a different expectation), actors tend to engage in repair work and come up with new expectations (GEELS; RAVEN, 2006), and a socio-technical niche might be insisted upon.

Aside from the differences between both niches, both niche networks were characterised by increased size, increased average distance, and decreased density of the researcher network. This may cause trust and information exchange to decline between the people involved. Thus, Butias niche did not necessarily become a denser network with improved exchange of information, which might mean that the new financial sponsors expectations might not affect the experimental process performance.

The main research limitation was the inclusion of interviews with niche researchers without extending them to other actors in the network. We proceeded in this way because we understood that they were able to answer the research question of whether public financial resources might contribute to transforming a technical niche into a socio-technical niche. This is because they knew who were participating inside the niches during the relevant time periods. However, we should return to the interviewees to ask about changes noticed with SNA, to determine what could improve the understanding of the network's dynamics. Despite this, it does not change the main results, which is whether sponsors may change a niche from a technical one to a socio-technical one. Finally, other actors in the network, besides researchers, must be included in future research, especially regarding our suggestions on future research questions.

Regarding future research questions, we observe that Field Configuring Events-FCEs (JOLLY; RAVEN, 2016) can bring about significant changes inside the socio-technical niche. Besides this, FCEs can contribute to upscaling, but both contributions need to be addressed. In addition, some questions are proposed after our research: Which policies are used after events by stakeholders to intervene in the socio-technical niche? How do stakeholders who participate in socio-technical events intervene in the existing regime? Are there differences in the shared cognitive rules between the central actors in technical and socio-technical niches? What changes in project results happened after the stakeholder's participation? Future studies might deepen the knowledge of the shared cognitive rules and expectations of the diversity of stakeholders incorporated in the transition from a technical niche to a socio-technical niche.

Acknowledgments

Thanks to Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) Clima Temperado for the availability of the head of the unit, the director of technology transfer and the researchers for the interviews and access to the information collected.

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E. Selection of bibliographical references): Marcelo Fernandes Pacheco Dias e Matias Ramirez.

Conflict of interest: the authors declare that there is no conflict of interest.

Source of funding: the authors declare that there is no source of funding.