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Collective action in Localized Agrifood System: an analysis by the social networks and the proximities. Study of a Serrano cheese producers' association in the Campos de Cima da Serra/Brazil.

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Abstract

Collective action within territorial organizations is complex. Initiatives often collapse from a lack of understanding of relational dynamics and logics of action. This article proposes a relational approach to study the collective action process within a producer association of a Localized Agrifood System (LAS). We conducted the research within the APROCAMPOS association, located in the Serrano cheese LAS, which involves producer families, extension agents, inspection veterinarians and secretaries of agriculture. We first conducted a social network analysis of advice seeking within the association, through sociometric interviews with the producer members. Second, an analysis of territorial proximity, conducted through semi-structured interviews with the association participants, was combined with the social network analysis. Results showed that extension agents are in a very central position in the advice network. They follow a classical top down model of knowledge diffusion. The president of the association plays a key brokerage role, essential for the network cohesion and information flow. Second, the analyses revealed a lack of trust and reciprocity among producers, leading to a low level of interaction and collective action, which can, however, be improved by the combination of geographical and organized proximities. In sum, the top-down model leads to low levels of initiative and participation among the producers in collective action. Local knowledge needs to be integrated in a more participatory governance frame to build common projects of cheese valorization. Nonetheless, institutional arrangements appear instrumental to define political orientation that favors cooperation and meets the quality of the Serrano cheese and promotes the development of the territory as a whole.

Key-words: Collective Action; Localized Agrifood System; Social Network; Proximity, Mountain Cheese; Brazil.

1. Introduction

Globalized and production-oriented agriculture often leads to spatial inequalities and the exclusion of peripheral rural regions (Torre and Vollet, 2016). Rural mountain regions, where cheese value chains are significant, are particularly affected by this phenomenon. Indeed, rural mountain areas are usually with poorly developed infrastructures, difficult to access and far away from political decision-making.

These areas can hardly compete with urban and more developed rural regions concerning generic resources (i.e. labor, wages and infrastructures) (Colletis and Pecqueur, 2004). However, globalization offers new paths of development for these territories through endogenous development based on local resources, local cultures and identity, in order to propose specific and differentiated goods and services (Pecqueur, 2001). This process depends on the ability of the local actors to act collectively to valorize the resources of the territory (Torre and Vollet, 2016).

Today we observe a growing interest in the concept of Localized Agrifood Systems (LAS), inspired by researches of regional science on local productive systems and by researches on sign of quality (Muchnik et al., 2007). The notion of LAS defines a type of organization of agrifood activities, which are productive and also have social and cultural dimensions (Muchnik, 1996). Territorial dynamics in LAS play a decisive role in the development of production activities and in the coordination that associates heterogeneous actors intervening directly or indirectly in these activities (Muchnik, 2009). LAS build on the links between humans, territory and products (Fournie, 2016). Although the spatial proximity between the actors of LAS favor exchanges, it is not the only determining element. Indeed, the organization capacities are also favored by the organized proximity. Organized proximity refers to either a belonging logic to networks of more or less formal relations, or to a similarity logic that corresponds to mental adherence of common categories (Torre and Beuret, 2012; Torre and Rallet, 2005). Organized proximity includes dimensions of social capital (i.e. bonding and linking social capital, trust) (Angeon et al., 2006; Putnam, 1993; 2000; Woolcock, 1998). Nonetheless, geographical proximity provides a framework for integrating space into interactions, which makes the approach by the proximities more interesting for our study (Polge, 2015).

The aim of our study is to propose a relational approach among members of a producer association within a LAS to grasp the construction processes of collective action. In this study, we define collective action as "the action taken by a group (either directly or on its behalf through an organization) in pursuit of members' perceived shared interests" (Marshall, 1998). According to Lazega (2006), the capacity of collective action relies on relational structures, which require the exchange of resources. Here, advice is of particular importance. Our study is part of the research

carried out on organizational processes and dynamics that accompany the implementation of territorial food governance. This kind of governance refers to forms of coordination allowing the various food actors of a territory, understood as "a developed space, socially constructed, culturally influenced and institutionally regulated" (Lopez and Muchnik, 1997), to take part in collective action promoting territorial resources (Fournie, 2016). Some rural studies associated the social network approach with the proximity analysis. This was the case in situations of dynamics of changes and innovation, i.e. among cereal growers in Burgundy reducing use of phytosanitary products (Compagnone and Hellec, 2015), among banana growers in Guadeloupe implementing agroecological practices (Houdart et al., 2011) or among dairy producers in Brazilian Amazon region in a context of environmental and technical pressure (Torre et al., 2018). Other rural studies apply these two frameworks to analyze local processes of economic development in Brazilian Amazon (Polge et al., 2016), or to study the relationship between individuals' dwelling unit locations and their kinship relations in Thailand (Verdery et al., 2012). The present article will complement this research, using both frameworks to enrich the reflections on collective action in LAS, more specifically focusing on the interactions between different actors (producers, extension agents, inspection veterinarians and local authority) within a collective organization, who committed to a process of defense and certification of a traditional mountain cheese in southern Brazil.

This study has been conducted in the Campos de Cima da Serra in southern Brazil, which presents low development indices, is isolated from large urban centers and has undeveloped transport and telecommunication networks (IBGE, 2018). This region holds the artisanal Serrano cheese value chain, a traditional mountain cheese value chain. The Serrano cheese, a raw milk cheese, is produced by family farms, with parents and their children on the farm. The value chain is a structuring element for the territory, because of its economic importance. In return, the territory exerts a strong influence on the actors of the value chain (marked identity, sense of belonging, cultural manifestations) which condition their practices and representations (Cruz, 2012). Today, we observe an important increase in demand of consumers for Serrano Cheese (Ambrosini, 2007) especially for young cheese of less than thirty days of maturation. However, this chain remains informal and cheese sales have become illegal.

Indeed, this product does not meet the sanitary standards for raw milk cheese because the Brazilian legal framework does not authorize the selling of raw milk cheese with less than sixty days of maturation. Also, national hygiene standards, adapted to big dairy industries, are incompatible with the reality of small-scale and artisanal production. Nonetheless, the first forms of collective action emerged the last decade in the region through the creation of four producer associations. Their objective is to act for the defense and the valorization of the Serrano cheese. In this study, we will focus on the APROCAMPOS association which is located in the municipalities of São José dos Ausentes and Bom Jesus and involves forty-seven producer families (nuclear family units living on the same farm), five extension agents, two inspection veterinarians and two secretaries of agriculture. This was the first association of Serrano cheese producers created in 2010 and it is today the most active one, with many activities undertaken (Ries et al., 2014).

In the context of informality of the Serrano value chain, it appears interesting to study collective dynamics among the actors of the association APROCAMPOS. For that, two theoretical analysis frameworks were combined:

- First, a social network approach seeks to understand how patterns of interactions among actors frame collective action in the association (Lazega, 2014). Additionally, the social network approach gives information on the role of each actor in the network and enables to see if some actors have more influence on collective action (Crona et al., 2011), particularly in terms of status. Here, two types of status are considered, the formal status in terms of formal position identified by higher socio-economic attributes (i.e. education, revenue), and the informal status which reflect the position of the individual in the network in terms of indegree centrality (number of advice request received) (Lazega et al., 2012). We will describe the advice network concerning farming and cheese making matters, thanks to data collected through sociometric interviews based on the roster method with the producer members of the association (Wasserman and Faust, 1994). For that, we showed the roster of all the actors involved in the association to forty-six of the forty-seven producer members so that they cite the names to whom they seek advice. We only asked the producers and not the other participants (extension agents, inspection veterinarians and agricultural secretaries) because advice seeking on

farming and cheese making matters concern above all producers. We consider both the formal advice network as the advices given by state institutions (i.e. extension services) and the informal advice network as the exchange of advice and information between peers (Isaac et al., 2007).

- Second, a territorial proximity analysis is combined with the social network analysis. It aims at defining how proximities shape social interactions and also act as levers to generate collective dynamics, pointing out the role of trust and conflicts. Indeed, the structural analysis of collective action necessarily needs to combine quantitative and qualitative approaches in order to have a thorough understanding of social phenomena (Lazega, 2014). Thus, the complementary approach by the proximities would make it possible to shed light on how proximities impact collective action, to perceive what the blocking proximities are and how to bring out new proximities that respond to the challenges of collective action (Torre and Beuret, 2012). For this analysis, we conducted semi-structured interviews with forty-six of the forty-seven producer members of the association. In addition, we realized a qualitative assessment of trust level and conflicts through semi-structured interviews with forty-six of the forty-seven producer members, and each extension agent, inspection veterinarian and secretary of agriculture.

The contribution is structured as follows: The next section outlines the conceptual framework, presenting the notions of LAS, territorial proximity, as well as the question of advice in agriculture. Then, the third section presents the study area, the Serrano cheese value chain as well as the methods. After that, the fourth part presents the results. Last, the fifth and sixth section outline the discussion and the conclusion.

2. Conceptual frameworks

2.1. The concept of Localized Agrifood Systems

The concept of Localized Agrifood Systems (LAS) appeared in 1996 as a result of research conducted by the CIRAD in Latin America and West Africa (Muchnik, 2009), inspired by researches of regional science on local productive systems (industrial districts, innovative milieu and clusters), but which little explored food systems; and by researches on sign of quality (Muchnik et al., 2007). The concept of LAS has emerged from the research on agri-food systems. It questions the production-oriented

model, integrating the notion of sustainability and territory (Fournier and Touzard, 2014; Muchnik et al., 2007). More particularly, LAS focus on the relations between food identities and productive techniques, between preservation of territorial resources and qualification of the products and between agriculture and other uses of the rural territory (i.e. tourism). Nowadays, the concept has spread to the international community. In particular, a European research group (GDRE) and a research and development network in Latin America working on LAS were created (Muchnik and Sainte Marie, 2016).

LAS was defined as "production and service organizations (agricultural and agrifood production units, marketing, services and gastronomic enterprises, etc.) linked by their characteristics and operational ways to a specific territory. The environment, products, people and their institutions, know-how, feeding behavior and relationship networks get together within a territory to produce a type of agricultural and food organization in a given spatial scale" (Muchnik, 1996).

LAS are based on a territorial approach and show the particularity of the relationship between human, territory (as a physical and symbolic resource) and identity food products. According to Canada and Muchnik (2011), their specificities rely on:

- the construction, activation and valorization of the links between human, territory and products;
- the identification of specific resources (material and immaterial) and their valorization, especially in terms of qualitative differentiation;
- geographically and socially coordination dynamics, articulating individual and collective strategies;
- diverse organizational forms, ranging from organized collective entities to fragmented atomized systems.

LAS allow synergy and complementarity among the heterogeneous actors in order to promote territorial resources. They bring forms of territorial food governance favorable to emergence of participatory dynamics, innovation and collective action (Fournie, 2016). The implementation of governance arrangements, such as producer associations, aims to gather around territorial issues and to

support and secure a framework for collective action. In LAS, collective organization becomes a specific territorial resource activated by the geographical and organized proximities.

2.2. Territorial proximity as element of understanding collective action in LAS

The notion of proximity has become a research path since the 1990s and has gained prominence, especially in the French literature (Filippi et al., 2018; Pecqueur and Zimmermann, 2004; Torre and Beuret, 2012). Since the 1990s, the French School of the Proximity, composed mainly of regional economists, plays a pioneering role in this area. The main objective of this research group is to determine the nature of the effects of proximity and to establish the endogenous role of space in economic theory (Gilly and Torre, 2000). In this study, we will decline two forms of territorial proximity: geographical and organized proximity (Torre and Rallet, 2005).

First, geographical proximity is a matter of distance. It corresponds to the number of kilometers separating two entities. It is relative to the morphological features of space, where topography plays an important role. This proximity can be related to the presence of transport infrastructures that allow mobility and information and communication technologies that allow ubiquity. This is called the functional distance (Bouba-Olga and Grossetti, 2008). The potential of interaction offered by geographical proximity will depends on whether it leads to conflicts or bring benefits. The geographical proximity can be desired between actors (permanent or temporary) or unwanted (neighborhood, etc.) (Torre, 2010; Torre and Beuret, 2012).

Second, organized proximity concerns the different ways for actors to be close, outside the geographical relationship. The term “organized” refers to any structured set of relationships without prejudging the form of the structure (e.g. firms, community). It corresponds to the ability of an organization to interact with its members (Bouba-Olga and Grossetti, 2008). The organized proximity is based on two essential, but not incompatible logics: the belonging and similarity logics (Torre, 2010).

- The belonging logic corresponds to actors of the same organization or the same network between which interactions are formed, such as exchanges of information or knowledge. Their relationship can

be direct or intermediated, and also unequal in power and in access to resources. It can be measured in terms of degrees of connectivity, which reflects a greater or less organized proximity and therefore a greater or lesser potential for collective action. It is under constant construction, by adding or removing new connections in human relations.

- The similarity logic corresponds to mental adherence to common categories; it results in individuals being at low cognitive distances from each other. This logic refers to the existence of institutions, formal or informal which model the thoughts and the actions of the individuals. The individuals share social norms, common language or common values in terms of culture and religion. Thus, they are better able to collaborate as they adhere to similar reference. It is based on logic of tacit and facilitates interactions between people who did not know each other before. People linked by the similarity logic have in common a certain number of resources, material (e.g. diplomas) or cognitive and normative (e.g. routines, values) (Bouba-Olga and Grossetti, 2008).

Geographical and organized proximities are neutral in their essence, they carry potential in terms of interaction and organization but can remain unexploited if they are not activated (Pecqueur and Zimmermann, 2004; Torre and Beuret, 2012). The combination of them constitutes a powerful factor of territorial governance, which allows to overcome conflicts and misunderstandings, but also to bring together agents who did not know each other or who led uncoordinated actions (Torre and Beuret, 2012).

Trust and conflict are important dimensions for the activation of the proximities and therefore cooperation. First, trust is an important component for any cooperative relations and organizations (Dupuy and Torre, 2004). Indeed, trust lubricates interactions between actors (Arrow, 1974). It develops over time and is facilitated by the quality and quantity of social relations. It enables collective action by the development of rules and norms and allows increasing knowledge sharing and learning process (Crona et al., 2011). Trust is a central condition for the activation of the proximities, and in return the proximities are important facilitators of increasing trust relation. Second, coordination among actors has also to consider power relations and the resulting conflict dimension.

Conflicts can be positive in collective dynamics when they lead to discussion and debate among actors having divergent interests or differing opinions (Torre and Beuret, 2012).

The proximity approach integrates the concept of social capital in the sense of Putnam, who defined it as "features of social organizations, such as networks, norms and trust and facilitate action and cooperation for mutual benefits" (Putnam, 1993). More precisely, organized proximity includes the bonding and linking dimensions of social capital, as well as trust (Angeon et al., 2006; Putnam, 2000; Woolcock, 1998). Indeed, the bonding dimension operates according to the similarity logic whereas the linking dimension operates more according to the belonging logic (Angeon et al., 2006; Polge, 2015). The approach by geographic proximity, in turn, provides a framework for analyzing interactions between actors located in a territory (Polge, 2015). In our study, we chose to use the proximity framework to consider simultaneously the organizational dimension and the spatial dimension in the analysis of social interactions.

2.3. Advice in agriculture

Since the early 1960s, the issue of technical and scientific knowledge diffusion to farmers has been central in agricultural development (Compagnone 2013; Darré 1996). Indeed, diffusion of innovations was considered as occurring, though a top-down model, occurred from researchers and extension agents to farmers, considered then as “receptors". To find an alternative to approaches based on the diffusion of technical and scientific knowledge, the role of extension agents has been often questioned since the 1980s in France. Indeed, it was showed that farmers do not merely implement the advice they received from experts (Darré, 1994; 2006). In fact, changing practices has a strong collective dimension. Farmers need to rely on their peers to master practices and to implement technical changes, according to their norms (Ruault and Lémery, 2009). Thus, the importance of professional dialogues among peers to understand the logics of action (Lazega, 2001) and to more precisely to understand the dynamics of technical changes in agricultural practice has been highlighted (Compagnone, 2004; Compagnone and Hellec, 2015; Darré 1996). Also, the social network analysis approach appeared promising to show the role of dialogic professional ties between peers in mastering technical changes (Compagnone and Hellec, 2015; Conley and Christopher, 2001; Foster and Rosenzweig 1995; Houdart

et al., 2011). This approach addresses local norms and social positions of individual within the social structure. In fact, members of a farmer group do not have the same opportunity to interact and any attempt to influence the group must take into account the structure of relationships and positions.

In this new paradigm of agricultural development, the extension agents should intervene in a logic of companioning to promote local knowledge through participatory approaches to respond farmers' needs (Darré, 2006). In fact, they should support the co-conception of knowledge between peers and also ensure to operate equitably in order to decrease social hierarchies and inequalities between social groups (Hoang et al., 2006). Moreover, society has today new concerns, which is putting pressure on farmers to further modify their practices and extension agents to help align farmers' practices with new models (Compagnone, 2013). However, despite this awareness, the reorganization of extension services linked to state withdrawal and privatization is reducing the ability of these institutions to co-produce knowledge in order to respond the farmers' needs (Compagnone and Simon, 2018).

3. Materials and Methods

3.1. The artisanal Serrano cheese

The artisanal Serrano cheese is a traditional raw milk cheese, produced as a by-product of beef cattle farming in the Campos de Cima da Serra in the states of Rio Grande do Sul and Santa Catarina. Sixteen municipalities within the federal state of Rio Grande do Sul and eighteen in the federal state of Santa Catarina produce artisanal Serrano cheese, together making up the Campos de Cima da Serra region (Fig. 1).

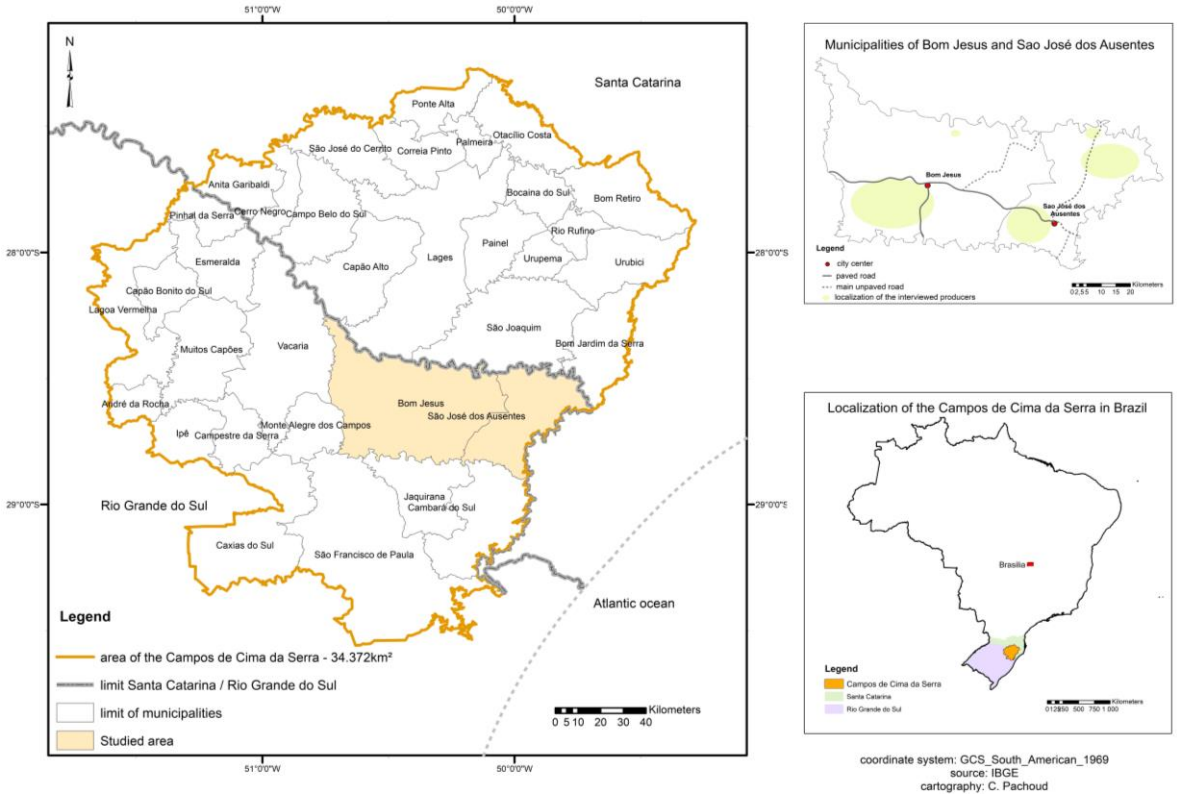


Fig. 1: Localization of the Campos de Cima da Serra and the municipalities of Bom Jesus and São José dos Ausentes. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Before the 1950', Serrano cheese was mainly produced by workers in capitalist farms. Inheritance customs divided the land equally between the heirs, which led to a fragmentation of the land over time. With the decrease in the size of the farm holdings the former landlords gradually became farmers themselves (Authors, 2019). Today, livestock farming is the prime economic activity in the territory (IBGE, 2018). There are about two thousand producer families and for most of them cheese making is the principal economic activity (more than 50% of the revenue). More than 90% of the farms are small-scale family systems. The most common production system is an extensive mixed dairy-beef livestock system; with dairy breeds and beef breeds simultaneously on the same farm. Only a few cows in any herd are milked for producing cheese, others are left to provide milk for the calves to produce beef. The herds graze on the natural pastures all year round, supplemented by temporary grazing on improved artificial pastures. Only 3% of the farms producing artisanal Serrano cheese are considered as intensive farming, which means dairy system without rising calves (Ambrosini, 2007).

However, cheese production is faced with administrative constraints. During the era of agri-food modernization in the 1950s, a law came into force[1] which prohibited the marketing of raw milk cheese with less than sixty days of maturation. The regulation aimed at standardizing production processes and hygiene standards and was designed under the pressure of food industries, disregarding artisanal production. Public institutions did not provide any support to producers to adopt standards and did not determine program aiming at preserving cultural traditions of artisanal row milk cheeses (Cruz, 2012). Today artisanal raw milk is gaining in recognition (Vitrolles, 2011). However, food industry puts pressure on public institutions to slow down the implementation of a regulatory framework on artisanal raw milk cheeses in order to restrain economic competition (Cruz, 2012; Sgarbi, 2014).

Most of Serrano cheese producers do not respect the restriction of minimum maturation because consumers prefer young cheese over matured one, and hence sell their produce within less than thirty days, which makes the sales illegal. Moreover, the sanitary norms in Brazil for dairy products do not consider the specificities of artisanal production, which are subject to the same sanitary standards and facilities as big dairy industries. Thus, making it impossible for small scale farmers to comply because of the high costs of adaptation (Cruz, 2012). Today, there are two kinds of certification authorizing the marketing of Serrano cheese but only for mature cheese, ripened for more than sixty days. First, the certification delivered from the municipal inspection service (SIM) authorizes the marketing of Serrano cheese within the area of the municipality. The inspection veterinarians employed by the prefectures of the municipalities control the health of the herd and the adequacy of the infrastructures. Only eighteen families have the SIM certification within the Campos de Cima da Serra. Second, at the state level, the law nº 14,973 and the decree n° 54.199 which legalize the commercialization of artisanal Serrano cheese were approved respectively in December 2016 and August 2018 (State of Rio Grande do Sul 2016, 2018). However, no producer has yet obtained the state certification. At the federal level, there is no legislation authorizing the Serrano cheese sales in the country. Nonetheless, producers claim that the high standards have a negative impact on artisanal characteristics of the cheese, for example, as they are required to replace wooden molds with plastic ones. Besides, the illegality of sale brings more health risks for the consumers in the long run, as there is no sanitary

[1] law n°1.28347/1952 through regulation n°30.69148/1952 (Presidency of the Republic of Brazil, 1950, 1952)

304 control (Cruz, 2012). Most of the milk processing facilities are very far from the norms required and
305 the lack of prospects for passing the farm on to the next generation makes the producers reluctant to
306 invest in new dairies (Sgarbi, 2014). In this context of informality, the majority of the artisanal
307 Serrano Cheese is sold locally by direct sales to consumers or in small markets of the region (Cruz,
308 2012).

309 In our study, we will focus on the two municipalities of Bom Jesus and São José dos Ausentes, in Rio
310 Grande do Sul because the two municipalities are the most active for defending legalization of the
311 Serrano cheese. Indeed, the first Serrano cheese producer association of the region, called
312 APROCAMPOS was created in 2010. Moreover, Serrano cheese production represents the main
313 economic activity coming from family farming in both municipalities, although they sometimes
314 diversify their production with other activities like growing of red berries, sheep breeding and
315 winemaking. More recently bed and breakfast accommodations opened directly in the farms. Half of
316 the SIM certification is located in these two municipalities (Table 1).

317 **Table 1: Production of Serrano cheese in Bom Jesus and São José dos Ausentes.**

	Bom Jesus	São José dos Ausentes	Campos de Cima da Serra
Number of Serrano cheese producer families	230	200	2000
Number of SIM certification	6	3	18

318 Today, forty-seven family farmers are members of the APROCAMPOS association (data on
319 production and size of the farms are presented in Table 2). Also, the five extension agents of the two
320 municipal offices of the EMATER-RS[2], the two inspection veterinarians and the two secretaries of
321 agriculture take part to the association. The two EMATER-RS offices are at the origin of its creation,
322 subsequent the increasing number of controls from the state sanitary inspection since the 2000s with
323 many cases of cheese confiscations. First, strategies of the EMATER-RS tried to valorize the Serrano

[2] The EMATER-RS is the private company of technical assistance and rural extension in the Rio Grande do Sul state. It was created in 1955. The municipalities have their own office with one or several extension agents working directly with the producers.

cheese, in projects with the objective of promoting the historical recovery of the cheese, characterizing the producing region and the cheese, registering and training producers and describing production and manufacturing processes. Second, they incentive the creation of associations. Many actions were successful, as the obtainment of rural credits to build dairies from public governments or private institutions, the vote of state law to authorize commercialization at the state level and the request of the designation of origin in 2017 (Ries et al., 2014). The president of the association, elected for two terms, deserves also interest. He and his family privilege a small-scale production valorizing traditional know-how, but at the same time another part of the production is SIM certified, produced in legalized dairy. The traditional production is sold in a niche market in São Paulo at the highest price throughout the entire territory (50$R/kg). He is also engaged at the state level for the cheese sale legalization.

Table 2: Average production and size of the farms of the forty-six family members of APROCAMPOS.

	Average	Minimum	Maximum
Number of cattle	76.0	14.0	300.0
Number of cows milked	14.0	2.0	40.0
Milk production (L milk/cow/day)	8.4	2.0	20.0
Cheese production (kg cheese/day)	11.3	2.0	70.0
Share of cheese income in total income	51.5	5.0	100.0
Total area (ha)	114.3	6.5	500.0
Area of natural pastures (ha)	78.4	3.0	460.0
Area of managed pastures (ha)	17.2	2.0	60.0

Infrastructures are little developed in the two municipalities. There are only two paved roads. The only means of transportation are private cars. The access to phone and internet is limited; the network only covers in the city centers and along the paved roads. Families of producers are isolated. Table 3 shows average distances from the farm to neighbors, city center and paved road of the forty-six interviewed families in the study.

341 **Table 3: average distances from the farm to neighbors, city center and paved road of forty-six family members of**
342 **APROCAMPOS.**

Distance (in km)	Average	Minimum	Maximum
to the nearest neighbor	0.9	0	3
to the city center of the municipality	27.3	1	52
to the nearest paved road	18.4	0	51

343 **3.2. Methods**

344 Interviews were conducted during three sessions of fieldwork: in February 2017, in August and
345 September 2017 and in March 2018 in order to be able to conduct interviews with all the selected
346 actors. During the three sessions of fieldwork, we established proximate relationships with local actors
347 especially the extension services and some producers, which allows also conducting informal
348 interviews and obtaining much information[3]. The forty-seven family members of the APROCAMPOS
349 association were identified thank to the help of the extension services. In fact, extension services are
350 central for the functioning of the association (i.e. they organize monthly meetings) and have a clear
351 idea about who participates in the association (Authors, 2019). The interviews were realized with
352 forty-six of the forty-seven producer members of the APROCAMPOS association because one of
353 them was not at home during the fieldworks. Interviews were conducted with the heads of the
354 household: for twenty families, man and woman were interviewed together, fifteen interviews were led
355 only with the woman and eleven with the man. Interviews were also realized with the five extension
356 agents, the two inspection veterinarians and the two secretaries of agriculture who are part of the
357 association and participate to monthly meetings. The method to collect and process the data is
358 described in the following paragraphs: qualitative assessment of trust between the actors of the
359 association (3.2.1), collection of social network data (3.2.2), collection of territorial proximity data
360 (3.2.3) and social network analyses (3.2.4).

[3] This study is part of a wider investigation integrating a historical analysis of the Serrano LAS based on the role of social capital to analyze emergence of collective dynamics and qualitative assessment of the organizational and institutional arrangements implemented within the LAS to evaluate the quality of the governance at the territorial level. Thus, observations emerging from the SNA and the proximity analysis will support the results obtained in the other studies within the Serrano Cheese LAS.

361 3.2.1. Collection of data on trust

362 Semi-structured interviews with producer members aimed at describing the production system, and
363 qualitatively documenting the trust level and conflicts with the other producers of the association,
364 extension agents, inspection veterinarians and secretaries of agriculture of the municipalities. For that,
365 direct questions were asked to the producer members to assess the level of trust ("Within the
366 APROCAMPOS, what is your level of trust, from low to high, toward the producers / extension agents
367 / inspection veterinarians / secretaries of agriculture of the municipalities?") and the level of conflict
368 ("Within the APROCAMPOS, how do you assess, from low to high, the level of conflict with the
369 producers / extension agents / inspection veterinarians / secretaries of agriculture of the
370 municipalities?"). If low level of trust and high level of conflicts were evoked, interviewed producers
371 should explain them. Interviewed producers should also indicate the frequency and the reasons of
372 meeting with the extension agents, inspection veterinarians and secretaries of agriculture. The other
373 actors involving in the association (extension agents, inspection veterinarians and secretariats of
374 agriculture of the two municipalities) were also asked through direct questions to assess the level of
375 trust and conflict with each of the actor categories of the association. Moreover, during the three work
376 fields, informal interviews and the participation to three association meetings allowed obtaining much
377 information on trust and conflicts between the actors of the association.

378 3.2.2. Collection of data on social networks

379 Social network analyses (SNA) provides tools to understand how network structures frame collective
380 action, as well as identifying important actors and analyzing their role in collective action (Lazega,
381 2014; Polge et al., 2016). This quantitative approach is commonly used to study how interactions
382 among actors and the resulting network configurations affect collective dynamics in agriculture. Some
383 studies used this approach to analyze social learning in the adoption of new agricultural technology in
384 Ghana (Conley and Christopher, 2001) and in the adoption of seed varieties in India (Foster and
385 Rosenzweig 1995). Other studies used SNA to understand the relationship between economic
386 development and the networks of information, capital and influence in rural Ghana (Conley and Udry
387 2001; Udry and Conley, 2004), or to analyze farmer advice networks on farming practices in cocoa

388 agroforestry systems in Ghana (Isaac et al., 2007). We used the roster method to document social
389 network (Wasserman and Faust, 1994). This method aims at asking the producer members to cite the
390 names of individuals they are connected with within the association through the use of the list of all
391 the participants. For that, we analyzed both formal and informal advice exchanges concerning farming
392 and cheese making matters to document advice relationships among actors. Advice exchange is central
393 in collective action because it illustrates the tacit dimension of the learning process among members,
394 central in collective action (Lazega, 2006; 2011). However, we only asked the producers and not the
395 other involved actors because advice seeking in farming and cheese making concern above all
396 producers. The study aimed thus at analyzing collective dynamics within the association. It is the
397 reason why (i) we included the two forms of advice: informal advice between the producer members
398 and formal advice from the extension agents, inspection veterinarians and secretaries of agriculture
399 (Isaac et al, 2007); and (ii) we did not seek if these exchanges occurred among members of the nuclear
400 family. We asked the producers to cite the names of who advise them on how to improve their farming
401 and cheese making activities ("who are the most important people of the association for advising you
402 to improve your farming and cheese-making activities on the farm?"), by showing them the roster of
403 all the actors involved in the association. We asked the question at the end of the interview because the
404 producers felt more comfortable with the interviewer.

405 3.2.3. Collection of data on territorial proximity

406 The analysis of the geographical and organized proximities was realized through semi-structured
407 interviews with the forty-six interviewed producer members of the APROCAMPOS association. First,
408 the questionnaire referred to the geographical proximity. The first questions were related to the
409 permanent geographical proximity. We asked each producer for the distance in kilometer from the
410 farm to the city center of their municipality, from the farm to the nearest paved road and from the farm
411 to the nearest neighbor (Table 2). Then, we asked questions concerning the temporary geographical
412 proximity. For each producer family, we asked for the numbers of travels to the city center per week,
413 the yearly frequency of participation in the monthly meetings of the association, in cheese contests and
414 in courses given by the extension services. Second, it referred to the organized proximity. We

considered that the belonging logic corresponded to the actors' advice network of the association APROCAMPOS. It means the forty-seven producer members, the five extension services and the two inspection veterinarians and secretaries of agriculture. The structural and positional approaches of the SNA allowed assessing this belonging logic. Regarding the similarity logic, we considered social norms in terms of culture and religion. For that, we asked the families if they participated to masses of local parishes, local rodeo contests and Gaucho fests, which represent important cultural celebrations in the region.

3.2.4. Social network analysis

We analyzed two networks: the advice network including the formal and informal advice relationships and the advice network of the informal advice exchanges between peers after removing the formal advice. For that, we used two kinds of approaches. First, the positional approach that aims at characterizing the position of each individual in the network using indicators. Second, the structural approach that aims at characterizing the network's structure at different scales: i. global, using indicators and an algorithm for communities' detection, and ii. local, using ERGM's to analyze connectivity patterns between pairs or triads of nodes. These analyses were conducted with R version 3.5.1 using the series of extensions dedicated to network analysis: igraph for descriptive measures (Csardi and Nepusz, 2006) and statnet for ERGMs (Handcock et al., 2008).

In order to identify central actors in the advice network, we computed two positional indicators for measuring actors' centrality on both directed networks, using the igraph package. First, the indegree centrality represents the number of edges incoming to a node. It measures the popularity and prestige (Wasserman and Faust, 1994) and can be used as an indicator of the informal status of actors (Lazega et al., 2012). Then, the betweenness centrality measures the number of times a node lies on the shortest path between other nodes (Borgatti et al., 2018; Wasserman and Faust, 1994). It allows identifying actors on directed network who are in a brokerage position, it means actors who act as "bridges" between actors or communities of the network, precising if they are giver or receiver of advice (Burt, 1992).

In order to document the cohesiveness of the network and the mutuality of the relationships, we computed structural indicators in igraph package on directed network for measuring: the density (proportion of ties in a network relative to the total number possible) on both networks and the reciprocity on informal advice network (producers mutually linked). The transitive triad corresponds to the scheme: actor i selects actor j, actor j selects actor k and actor i selects actor k (Wasserman and Faust, 1994). This form of triad signals a concentration of leadership by actors who have a higher formal or informal status (Lazega, 2011). The cyclic triad corresponds to the scheme: actor i selects actor j, actor j selects actor k, who in turn selects actor i. In this form of generalized exchange, trust comes into play (Lazega, 2011). We computed the number of transitive and cyclical triads on the informal advice network implemented in igraph package. In order to inform on the fragmentation of the network, we used for both networks the community structure detection method (Crona et al., 2011) based on the Girvan–Newman algorithm implemented in igraph package (Newman and Girvan, 2004). A community corresponds to groups of individuals that are more connected to each other compare to the rest of the network (Borgatti et al., 2018; Lazega, 2014).

Last, in order to control for the effects of endogenous and exogenous processes in shaping the advice network, we used ERGM (Exponential Random Graph Model). ERGM was implemented on the directed network including the formal and informal advice in statnet to quantitatively analyze the networks' structure. These models allow testing if the structure of the observed network differs from what would be expected if relationships were established randomly, and to further detect which variables contribute to explain its structure. These variables can be of two kinds: endogenous, i.e network-dependent effects reflecting processes of self-organization and exogenous and directly linked with the structure of the studied network, i.e linked to the attributes of the nodes, reflecting the formal status of the producers (Lazega et al., 2012) and to independent dyadic phenomena (Lusher et al., 2012; Robins et al., 2007). We list in Table 4 all the variables selected and the associated hypothesis concerning social processes involved in ties establishment.

Table 4: Variables selected for the ERGM of advice network.

	Terms	Process	Hypothesis

Structure variables (endoge-nous)	Edges		Density (base term)	The probability of existence of a link corresponds to the density of the network
	GWESP		Common partners between nodes which are tied (triad closure)	Two actors linked to a third one tend to establish advice ties
	GWDSP		Common partners shared by two individuals, whether connected or not (multiple connectivity)	
Exogenous variables	Attributes reflecting the formal status of the producers	Price (node attribute)	Price of the cheese per kg	Producers having a higher formal status are more likely to be sought for advise
		Production of cheese (node attribute)	Quantity (kg) of cheese produced per day	
		Level of intensification (node attribute)	Intensive system (dairy breeds, artificial insemination, supplementation all year round) (vs traditional system (mixed dairy-beef herd, natural service, supplementation only in winter))	
		Position in the association (node attribute)	Members part of the board of direction (vs members not part of the board of direction)	
		Certification (node attribute)	SIM certified production (vs not SIM certified)	
		Diploma (node attribute)	With tertiary education	
	Geographical proximity	Distance to center (node attribute)	Distance of the farm to the city center (km)	Geographical isolation of the producers decreases the likelihood of being sought for advice
		Distance to road (node attribute)	Distance of the farm to the paved road (km)	
		Municipality (node attribute)	Living in Bom Jesus vs São José dos Ausentes	
		Distance (independent dyadic phenomena)	Distance between two actors of a dyad (km)	

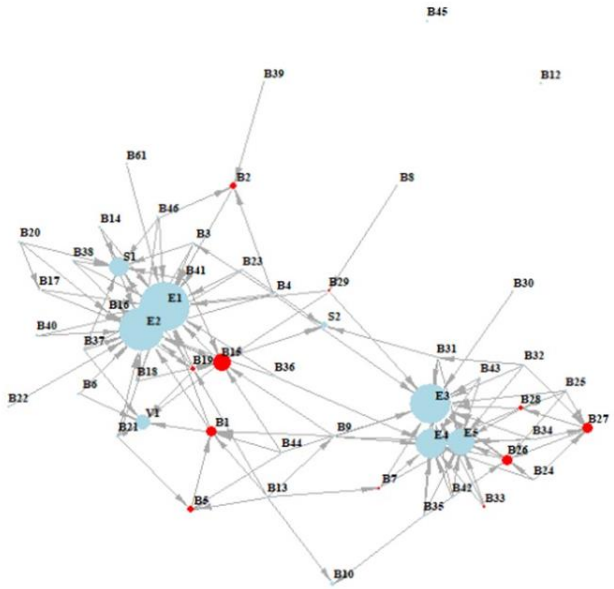
	Organized proximity	Church (node attribute)	Masse participation	Participation to cultural celebrations increases the likelihood to be sought for advice
		Rodeo contest (node attribute)	Rodeo contests participation	
		Gaucho fest (node attribute)	Gaucho fests participation	

4. Results

4.1. Social network analysis

Fig. 2 presents the advice network including the formal and informal advice (all the participants of the association) documented through sociometric interviews with the forty-six producer members of the APROCAMPOS association.

Nodes	54
Links	135
Density	0.05



Legend

B: Producer	V: Veterinarian	Producer SIM certified
E: Extension agent	S: Secretary of agriculture	Vertex size: indegree

Fig. 2: Network including formal and informal advice of the APROCAMPOS association. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

474 4.1.1. Trust and Positional indicators

475 The descriptive analysis of the network including formal and informal advice with igraph (Fig 2.) first
476 shows that the actors who were the most cited by the producers, i.e. having the highest informal status,
477 are the extension agents of both municipalities (a total of eighty citations). Some other actors have in
478 less extent a high indegree, like one inspection veterinarian (V1), one secretary of agriculture (S1) and
479 one producer who is the president of the association (B15). The actor having the highest betweenness
480 centrality is the producer B15, president of the association (betweenness centrality=10). He received
481 advice seeking from seven producers, however he sought advice only from formal sources of
482 information (extension agents, veterinarians and secretaries of agriculture). In sum, advice seeking rely
483 mainly on formal sources of information (71.8% of the advice receiving ties), principally on extension
484 services (59.3% of the advice receiving ties) (Table 5). The centralized network, with extension agents
485 being at the center, demonstrates a top-down model. The president, in brokerage position, plays a
486 central role in the information flow from formal source of information to peers and also in the network
487 cohesion, linking more peripheral producers.

488 **Table 5: Number and proportion of advice receiving ties (indegree) according to the formal or informal sources of**
489 **information.**

		Total number of advice receiving ties (indegree)	Share of advice receiving ties (%)
Formal advice seeking to:	Extension agents	80	59.3
	Inspection veterinarians	6	4.4
	Secretaries of agriculture	11	8.1
	Total of formal advice ties	97	71.8
Informal advice seeking between peers		38	28.2
Total		135	100

490 Results of the qualitative assessment of the trust level between the producer families and the other
491 actor categories of the association are summarized in Table 6.

Table 6: Assessment of the level of trust between the producer families and the other actors of the APROCAMPOS association.

	Producers
Producers	-
Extension agents	+
Inspection veterinaries	+/-
Agricultural secretaries	-

Level of trust: low: -; medium: +/-; high: +

The assessment of trust shows that the extension agents are the only actors of the value chain who enjoy a high level of trust from the producers, also supported by the highest indegree. Forty-five of the forty-six families of producers qualified the level of trust with the extension services from good to high. The extension services are the only structure for advising the producers on farms, in average one visit per week to one per month.

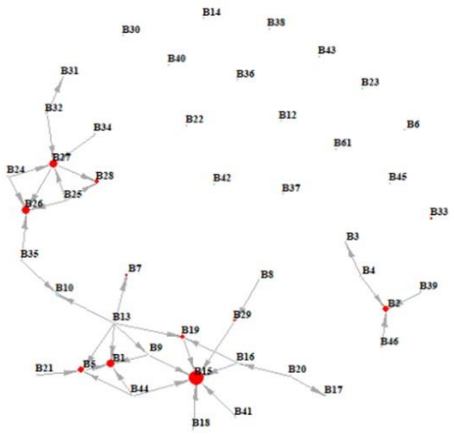
Concerning the inspection veterinarians, they interact only with legalized producers or those who want to start the process of legalization. It is the reason why only twenty-nine of the forty-six families could not assess their trust level as they do not work with inspection veterinarians. Among the respondents, fourteen considered their trust level from good to high and three as low. The trust level depended mainly on the role that the veterinarian takes. In São José dos Ausentes, the veterinarian takes a role of adviser and is a lot engaged in the legalization struggle in the association and at the state level. She enjoys a good reputation to the producers and got a relatively high indegree (six citations). Whereas, in Bom Jesus, the veterinarian takes a role of controller; establishing a relation of authority with producers. He was not cited on the advice network and two families claimed having conflicts with him.

Last, the relationships between the agricultural secretaries and the producers are much more contrasted. Indeed, twenty-nine families of producers qualified the trust level with the agricultural secretaries from good to high, sixteen as medium to low and one did not answer. However, many producers complained that the politics do not support the small-scale producers and the artisanal

514 cheese production, their opinion is much more a question of family or political proximity. This is the
515 reason why producers do not seek many advices to the secretaries of agriculture.

516 Fig. 3 presents the informal advice network between the forty-six producer members of the
517 APROCAMPOS association, after removing formal advice.

Nodes	46
Links	38
Density	0.02
Reciprocity	0
Cyclical triads	0
Transitive triads	7



Legend ● Producer SIM certified

B: Producer Vertex size: indegree

518 **Fig 3. Informal advice network between peers of the APROCAMPOS association. (For interpretation of the**
519 **references to color in this figure legend, the reader is referred to the Web version of this article.)**

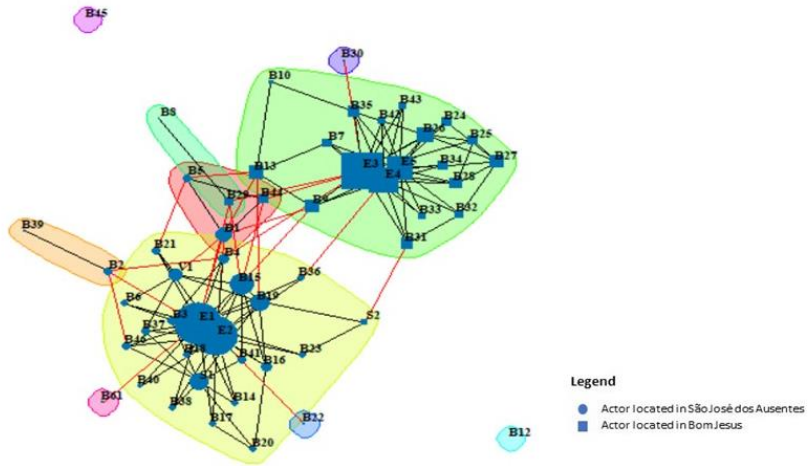
520 When focusing on the informal advice network for positional indicators (Fig 3.), we observe that the
521 producer with the highest indegree, it means the most popular and prestigious producer among peers,
522 is the president of the association (indegree=7). B1, B26 and B27 have also, in a less extent, a high

indegree (indegree=4). These four central producers have the SIM certification. Moreover, B1, B15 and B26 are part of the board of direction (B15 is the actual president and B1 was the first president). This result show that these four popular producers, having a SIM certification and being members of the board of direction, have a higher formal and also informal status for advice among peers. Considering the betweenness centrality, we observe that the values are low. B27 has the highest betweenness centrality, equal to 5. This producer, who is SIM certified, is giver and receiver of advice. Otherwise, betweenness centrality is equal to 0 for forty producers and it is comprised between 0.5 and 2 for five producers. Moreover, we observe that producers only cited thirty-eight times another producer, it means 28.1% of the total advice seeking ties (Table 5). This demonstrates a low advice flow among peers. This observation supports the trust assessment between the producers in which low trust level among producer families (Table 6). Latent conflicts were also identified, especially among certified and non-certified producers. The first ones claimed that (i) the non-certified do not respect the hygiene standards which represented a danger for the consumers and affected the image of the producers using good practices; and that (ii) they sell to a lower price which leads to a price decrease for the certified producers. On the other side, many non-certified producers claimed that the legalized ones do not produce traditional cheese anymore, because of the standards that change its characteristics. Also, there were jalousie feelings. Some producers claimed that some certified producers are favored by the extension services and the inspection services, applying less exigent standards. Moreover, results indicate that 43% cited extension agents in first position, then 33% of the producers cited the nuclear family (not included in the result as intrafamily ties are not analyzed), but only 13% cited other producers at the first place. This information cannot be integrated in the quantitative analysis but appeared important to show the lack of advice exchange between families.

4.1.2. Structural indicators

Concerning the structural indicators on the advice network including all the actors of the association (formal and informal advice) (Fig 2.), we observe that the density is low (0.05) because the mean number of ties established by producers is low (2.9 per producer; SD=1.5). The network is centralized, the extension agents being at the center. Regarding the community detection presented in the Fig. 4,

550 the community structure detection method based on the Girvan–Newman algorithm allows
551 distinguishing two big communities (green and yellow) which corresponds to the spatial repartition of
552 the actors according to their municipalities. The nodes which appear at the edge of the two big
553 communities and in the in-between small red community are producers geographically located at the
554 border of the two municipalities. Then, there are three peripheral families, tied by only one actor. Last,
555 two isolated nodes appear in the network. The two families claimed to not receive advice from outside.
556 They have a small level of production; they receive seldom visits from the extension services and have
557 no contact with the inspection veterinarians. Also, they are moved away from the community life
558 (little participation to the association, contests, courses, etc.).



559

560 **Fig. 4: Community repartition on the network including formal and informal advice of the APROCAMPOS association. (For**
561 **interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)**

562 Relating to the informal advice network between peers, after removing formal advice (Fig 3.), the
563 density was 2.5 times lower compared to the whole advice network. It means that producers interacted
564 little for advice (0.8 per producer; SD=1.2). There was no reciprocity. The network counted seven
565 transitive triads but no cyclical triads. These results show a lack of exchange between producers for
566 advice and a lack a trust due to the absence of reciprocity and cyclical triads. Then, the community
567 detection among peers based on the Girvan–Newman algorithm (Fig. 5) shows that there are four
568 communities in the network. The producers among a community interact mostly within the
569 neighborhood. Fig. 1 shows the repartition of the farms within the municipalities. We observe that two

communities (red and orange) are located in the southeast of the study area, one community (yellow) in the southwest and one other (green) in the northeast. Nonetheless, the network is sparse with many isolates (fifteen families) and three dyads formed between neighbors at the periphery.

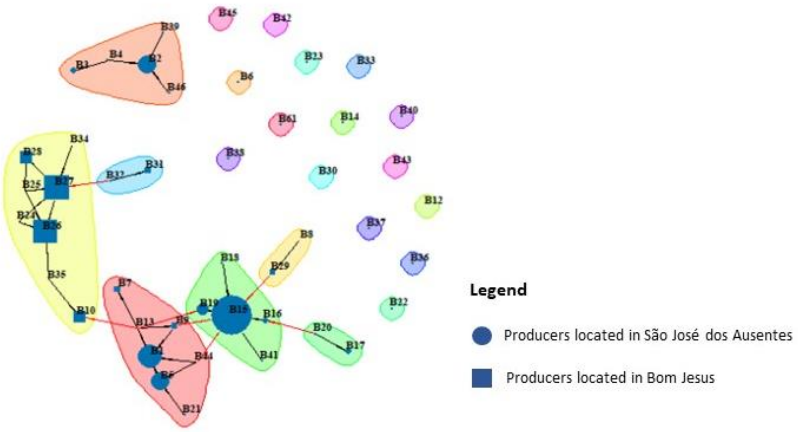


Fig. 5: Community repartition on the informal advice network among peers of the APROCAMPOS association. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

4.1.3. Statistical analysis on the advice network

The results of the final model for statistical analysis on the directed network including formal and informal advice is presented in Table 7.

Table 7: Estimated coefficients and standard errors for the parameters of the final model.

Terms	ERGM
Edges	-1.59 (0.26) ***
GWESP	0.81 (0.23) ***
GWDSP	-0.52 (0.07) ***
Price of cheese sale (R$)	0.05 (0.02) *
Intensification level (traditional)	-0.69 (0.18) ***
Diploma (tertiary education)	0.90 (0.19) ***
Distance to paved road (km)	-0.03 (0.01) ***
Municipality (Bom Jesus)	-0.71 (0.17) ***
Rodeo contest participation	-0.79 (0.20) ***

Akaike information criterion	**1077**

Parameter estimates are expressed in log-odds with their standard deviation (SD) in parentheses. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

ERGM results first showed that the distribution of the edges in the network was unlikely to be due to chance as the edge effect was significant (-1.59; p<0.001). The best model with respect to the AIC retained endogenous variables and attributes reflecting socio-economic status of the producers, geographical and organized proximities presented in Table 7. Goodness of fit results are presented in Appendix. Concerning the endogenous variables, transitive closure effect was significant (0.81; p<0.001), indicating that producers were more likely to establish ties if they had common exchange partners. Correlatively, the significantly negative estimate for multiple connectivity indicated that untied actors have a lower probability to have common partners than at random for advice seeking (-0,52; p<0.001). The conjunction of a positive triad closure effect (GWESP) accompanied by an absence of cyclical triad, showed previously with igraph package, demonstrate that triads are transitive. It means that there is a local hierarchy by a concentration of leadership in advice toward individual of higher formal or informal status.

We then computed estimates for exogenous variables corresponding to producers' attributes reflecting their formal status, to test if they influenced the probability of emergence of advice relationships among individuals. There was a marginally significant effect of the price at which producers sell cheese on advice ties probability (0.05; p<0.1), indicating that producers who sale at a higher price were more sought for advice. There was also a significant effect of the level of intensification: producers with traditional production system were less sought for advice than producers having a more intensive production system (-0.69, p<0.001). Last, producers with a higher education level were more sought for advice (0.90; p<0.001). The position of the producers in the association (i.e. if he or she was at the board of direction or not), the ownership of the SIM certification as well as the quantity of cheese produced did not have any significant effects on advice ties emergence probability. To sum up, cheese price, intensification level and education appear to be key factors determining the formal status of the producers for advice.

606 Last, we tested if the advice relationships within the network were structured by other external
607 attributes than individuals' attributes, and tested for the effect of variables related to geographical
608 proximity and to organized proximity for the similarity logic. Concerning the geographical attributes,
609 we found that families which are located far from paved road were less sought for advice (-0.03;
610 $p<0.001$). Although we found that there was a significant effect of the municipality: the producers of
611 Bom Jesus were less likely to form advice ties compare to the ones located in São José dos Ausentes (-
612 0.71; $p<0.001$). There was no significant effect of the distance between two actors in creating advice
613 relationships. Then, considering the attributes related to the similarity logic of the organized
614 proximity, producers who do not participate in rodeo contests were less sought for advice (-0.79;
615 $p<0.001$). However, the participation in masses and Gaucho fests were not significant. In sum, the
616 more the producers were isolated the less they were sought for advice. Proximity to roads had a
617 positive effect on the probability of formation of an advice tie. Moreover, rodeo contests, as important
618 cultural event, increased interactions between producers of the association for advice.

619 **5. Discussion**

620 The advice network analysis among actors of the producer association APROCAMPOS showed that
621 the extension agents are the most prestigious and popular actors. The network is centralized on the
622 extension agents, having the highest indegree. The qualitative analysis revealed that they are the most
623 important actor for advising producers directly on the farm and they further enjoy a high level of trust
624 from the producers. Thus, the majority of advice regarding farming and cheese making matters is
625 sought from advisors and not from peers. This result demonstrates a top down model in which advices
626 are transmitted from extension services to producers.

627 Previous studies showed that extension agents are the drivers of collective action: they incentive the
628 creation of the associations and they are central for its functioning (for example they organize the
629 meetings and set the agenda) and for inviting new members (Authors, 2019). However, the top-down
630 process shows limitations, in which local knowledge is not integrated in projects of cheese
631 valorization. Also, Vitrolles (2011) brought forward the same scheme for the registration of the
632 Serrano cheese under a geographical indication: few producers understood that was the purpose of this

633 tool. Even if Marwell et al. (1988) showed that the centralization of network ties can have positive
634 effects on collective action, it depends mainly on single persons. In our study, extension agents
635 showed a high level of initiatives however many findings have already demonstrated that top-down
636 models are rarely efficient and successful for collective action while a bottom-up process requires the
637 broad involvement of local people (Ostrom, 2004). In this sense, Hoang et al. (2006) demonstrated
638 that extension agents tended to contact more powerful and wealthier farmers, reinforcing local
639 hierarchies. Moreover, knowledge of the producers is most of the time undervalued. To better respond
640 to producer needs, local knowledge needs therefore to be enhanced in more participatory governance
641 frame (Darré, 1996). For that, the extension agents should intervene in a logic of companioning to
642 support the exchange of advice and information, and therefore the co-conception of knowledge among
643 peers (Compagnone and Hellec, 2015; Darré, 2006).

644 Further results showed that the producer president of the association is in brokerage position in the
645 advice network. He seeks advice from extension agents, inspection veterinarians and secretaries of
646 agriculture and gives advice to peers, strengthening thus the top-down model of advice flow.
647 Nonetheless, this actor plays a central role in the network (Burt, 2005). He links the different
648 communities and peripheral producers within the networks through his brokerage position. In this
649 sense he has a role in cohesion and equity by advising more marginal producers. Also, he is crucial for
650 the information flow from formal source of advice to the peers, learning process and also
651 implementation of innovations that emerged from he and his family. The president and his family for
652 example developed an innovative cheese making process and sold cheese in a niche market in São
653 Paulo. Moreover, during the interview it became apparent that the president established relationships
654 with extraterritorial actors, who served as instrumental support for the defense of the cheese at an
655 upper scale. Indeed, he has relationships with several researchers at the national or international level
656 and one state deputy active in the struggle for the cheese legalization. In this sense, this actor has a
657 central role in collective action and therefore in governance.

658 Considering the informal advice network among peers for the positional indicators, we observed first
659 that the most prestigious and popular producers, having the highest indegree (informal status), are the

president of the association, and in a lesser extent, three other producers. They all have the SIM certification and three of them are part of the board of direction (including the actual president and the first president). Thus, among peers, the SIM certification and the membership to the board of direction seem to be determinant attributes to define producers of higher formal status, more sought for advice. These producers of higher informal and formal status play in important role for advice. However, the presence of extension agents in the roster could have reduced the number of advice seeking ties toward producers and the two attributes were not significant in ERGM. In this sense, the informal advice network could deserve further research, including the implementation of ERGMs. Nonetheless, the focus of our study is the analysis of collective action within the association and required for that the inclusion of all the involved actors. Second, the betweenness centrality is overall low among peers in the directed network, which strongly inhibits advice flows and limits network cohesion.

The structural approach defined two main communities in the network including formal and informal advice, corresponding to the geographical dispersion of the actors according to their municipality. The network was centralized with few isolates, extension agents of each municipality being at the center of their respective communities. Lazega and Pattison, (1999) demonstrated that higher cohesion in smaller communities allows a better accessibility to the actors to the whole network, preventing exclusion of the more peripheral ones. Further, Marwell et al. (1988) showed that higher interdependence among actors, through a higher density network, demonstrated better potentials of collective action. Moreover, in the informal advice network, there was neither a direct nor indirect (cyclic closure) reciprocity among producers. This network turned out to be sparse, without reciprocity and with many isolates. Thus, advice exchange among peers is low, producers rely largely on formal advice. Further, the community detection allowed defining four communities and three dyads which gather producers living close. Advice exchange between peers seems to occur more at the neighborhood scale than at the municipality scale as showed in the advice network including formal source of information.

Furthermore, the qualitative analysis showed that producers stay in their families and rarely move. Also, one third of the respondents cited the nuclear family in first position to the question related to

687 the advice network, although they were not asked to cite the nuclear family. These results revealed a
688 lack of exchange, trust and reciprocity between the producer families. Building on the work carried out
689 by Sligo and Massey (2007), the producers show characteristics of pre-modern society in respect of
690 trust, as defined by Giddens (1990), which is based predominantly on localized and intrafamilial
691 relationships. According to Ostrom (2010), the level of collective action depends on three variables:
692 trust, reputation to be trustful and reciprocity. Repetition of interactions leads to positive
693 reinforcement of these three variables and to a higher level of cooperation. Previous observations
694 showed that the lack of trust and reciprocity decreases the level of collective action. There was a lack
695 of engagement of the producers in the association, for example only few of them participate regularly
696 in the meetings. More generally, few producers are members of the association, which represents,
697 despite the top-down approach, the only collective organization acting for the defense of the Serrano
698 cheese (Authors, 2019). Moreover, the informality of the value chain could also explain the lack of
699 interaction and trust which do not favor cooperation and rather generate conflicts. The qualitative
700 approach highlighted latent conflicts among certified and not certified producers. Also, conflicts were
701 observed among producers and inspection veterinarians, as well as secretaries of agriculture. Conflicts
702 with veterinarians happened when they take the role of controller rather than adviser. Concerning the
703 secretaries of agriculture, many actors indicated that they do not support the cheese production
704 enough. This may thus be a major lock-in factor for the development of the value chain. According to
705 Torre and Beuret (2012), conflicts are part of participatory processes but they have to be revealed and
706 discussed between the actors to move forward concertation. In this sense, the association shows
707 potential to resolve conflicts, by bringing actors together. Furthermore, previous works showed that
708 the history of the region could also illustrate the lack of interaction and trust. Until the 1950s, there
709 was no cooperative relationship between the Serrano cheese producers as cheese was mainly produced
710 by workers in capitalist farms. Today the higher necessity to defend the traditional cheese facing
711 growing industrialized food processes led to the need for cooperation between the new family
712 producers (Authors, 2019).

Then, effects of endogenous and exogenous processes had a role in shaping the network including formal and informal source of advice. The significant over-representation of triad closures in the networks highlighted by ERGMs results and the absence of cyclic triads defined by igraph package showed that triads are transitive. This demonstrated a local hierarchy in advice, which indicates that some actors have a certain authority linked to their formal or informal status (Lazega et al., 2012). In fact, the actor seeking advice acknowledges the status of the advisor, which may be informal or formal. Here it is clear that extension agents have the most prestigious informal status for advising, as they have the highest indegree centrality. They enjoy also a higher formal status considering the revenue and the educational level, compared to family farmers. Nonetheless, producers of higher formal status, represented by a higher diploma, a higher intensive production system and a higher cheese selling price, tend to be more sought for advice. Studies have shown that status-differentiated groups will tend to be more successful in collective action. Status acts as a coordination mechanism: members of higher status initiate collective action and contribute at higher levels and influence those of lower status to follow with larger contributions (Berger et al., 1977; Simpsons et al., 2012; Willer, 2009).

Variables related to proximities brought elements of understanding of the interactions' patterns of the advice network. Concerning the geographical proximity, the lack of infrastructures, for example paved roads or internet and telephone networks, extends the functional distances which may result in a decrease of interactions and in return leads to a lack of trust and reciprocity among the families. Not surprisingly, statistical analysis showed that the higher the distances from farm to paved road are, the less people interact. In the same way, Houdart et al. (2011) showed that geographical proximity, facilitated by the presence of roads, increase the opportunity of encountering and therefore had an important role in advice exchange. Also, community detection showed that actors interact firstly within their municipality. The natural tendency of withdrawal on a local logic, but also on similarity logic of coordination was also showed by Polge et al. (2016), who worked in "Territories of Citizenship" in the Brazilian Amazon. Cooperative relations and trust for collective action can be improved by incentives to meet each other in order to build organized proximity (Torre and Beuret,

2012). Several levers exist to favor interaction occasions between actors who would not necessarily meet otherwise. Polge and Torre (2018) demonstrated that in two public policy arrangements in the Brazilian Amazon, great distances between actors made their interactions difficult but not impossible. For that, the improvement of the infrastructures and punctual support for the cost of transport were applied to facilitate the translocation and to increase temporary geographical proximity. Moreover, geographical proximity needs to be crossed with organized proximity to develop interactions. Indeed, participation in cultural life (e.g. rodeos contests) allows increasing the interaction opportunity. However, cultural events do not occur often, for example, masses happen once a month and gaucho fests only few times a year, which do not provide many opportunities for encounter. The association meetings are the best way to increase interactions and trust between producers. Similarly, other initiatives undertaken by extension agents, such as cheese contests and courses offered to improve production allow the development of new spaces of interaction. At the end, increasing interaction would eventually lead to higher trust between the producers (Crona et al., 2011). Nonetheless, the construction of a belonging logic of organized proximity needs to exceed the level of sole participation of local actors of the Serrano cheese value chain (producers, extension agents, inspection veterinary). The development of interactions at an upper-level (inter-municipality, state or federal level) through the construction of institutional arrangements are crucial (Polge et al., 2016). In fact, the Serrano cheese represents an important specific resource for the territorial development which needs implementations of specific policies to achieve quality standards and qualification (Colletis and Pecqueur, 2004). Also, cooperation with other territorial actors, among others tourist operators, seems highly recommendable. These are instrumental conditions for favorable territorial food governance frameworks to implement common projects of development.

However, three limitations of this paper need to be mentioned. 1) The inclusion of formal institutions, especially extension services, has certainly reduced the number of advice ties that could have occurred within peers. Indeed, giving technical advices for the extension agents is a part of their job. Nonetheless the focus of this study are collective dynamics within the association. That is why it was crucial to include all actors involved in the association. 2) Producers tended to quote extension agents

767 because of the turn of the question (“most important”), it might have been better to ask ”whom do you
768 ask for advice concerning farming and cheese making matters?”, or even distinguishing the formal and
769 informal advice seeking in separated questions. Also, the informal advice network could deserve
770 further research, including the implementation of ERGMs. The meaning of advice could be better
771 defined in a sociometric question because this notion could hold different meanings of advice, which
772 connect different people and yield different structures (Cross et al., 2001). 3) Advice relationships tend
773 to make more ordinary social relations between peers invisible (e.g. personal support), that can lead to
774 other network structures (Cross et al., 2001).

775 **6. Conclusion**

776 The relational approach combining network and proximity analyses appeared to be of particular
777 relevance to study collective action within a LAS. Based on the example of the APROCAMPOS
778 association in the Serrano cheese LAS, we showed that social interaction patterns influence collective
779 action. The top-down process conducted to centralized network, in which extension services were
780 drivers of collective action but producers were not fully involved in projects of cheese valorization.
781 Also, the absence of reciprocity and a lack of trust among producers led to a low level of cooperation.
782 At the same time, geographical isolation and bad infrastructures seem to limit their interactions.
783 Producers need to increase the number of interactions to improve trust and reciprocity and therefore
784 collective action. In this sense, territorial proximity through for example association meetings or
785 cultural life gives opportunities of interactions. Nonetheless, institutional arrangements appear
786 instrumental to favor interactions at an upper-scale to define political orientation through the
787 implementation of specific policies. Also, cooperation with other actors of the territory to integrate
788 different goods and services are central in an objective of territorial development.

789 In conclusion, a top-down model leads to low level of initiative and participation of the producers in
790 collective action. Local actors need to build common projects together for the valorization of the
791 Serrano cheese in order to master their own model of development. For that, they require a more
792 participatory governance frame, through horizontal coordination among the actors of the Serrano
793 cheese LAS, which involved producers, extension services and local authorities. Nonetheless, the

integration of the different scales of action to implement specific policies and also the establishment of cooperation with other territorial actors, related for example to the increasing tourism in the region, promote the creation of enabling an environment for territorial food governance. The combination of these elements is crucial to meet quality standards and qualification of the Serrano cheese and in a larger extent to the development of the territory as a whole.

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Appendix. goodness of fit results for directed advisory network

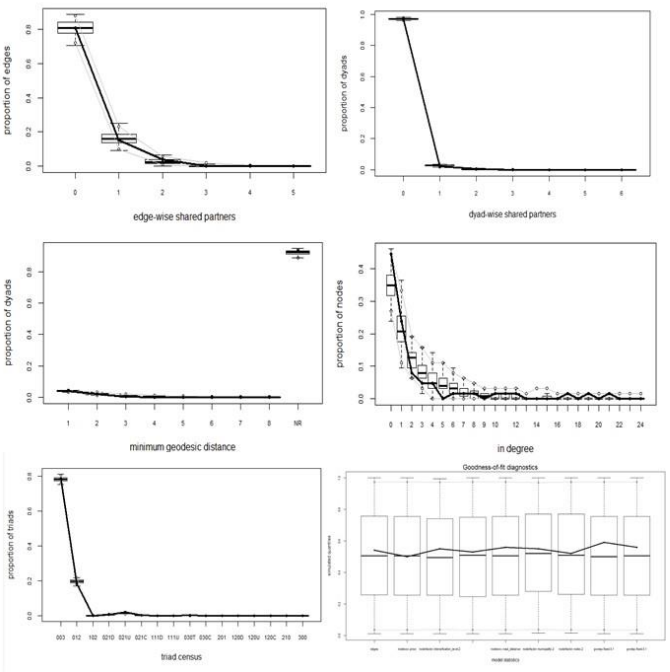


Figure A: goodness of fit results for edge-wise shared partners, dyads wise shared partners, minimum geodesic distance, indegree and triad census parameters and for the statistical model for directed network including formal and informal advice (see Hunter et al., 2008).

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