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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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1 **Abstract**

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

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

23 **1. Introduction**

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

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

34 Today we observe a growing interest in the concept of Localized Agrifood Systems (LAS), inspired by
35 researches of regional science on local productive systems and by researches on sign of quality
36 (Muchnik et al., 2007). The notion of LAS defines a type of organization of agrifood activities, which
37 are productive and also have social and cultural dimensions (Muchnik, 1996). Territorial dynamics in
38 LAS play a decisive role in the development of production activities and in the coordination that
39 associates heterogeneous actors intervening directly or indirectly in these activities (Muchnik, 2009).
40 LAS build on the links between humans, territory and products (Fournie, 2016). Although the spatial
41 proximity between the actors of LAS favor exchanges, it is not the only determining element. Indeed,
42 the organization capacities are also favored by the organized proximity. Organized proximity refers to
43 either a belonging logic to networks of more or less formal relations, or to a similarity logic that
44 corresponds to mental adherence of common categories (Torre and Beuret, 2012; Torre and Rallet,
45 2005). Organized proximity includes dimensions of social capital (i.e. bonding and linking social
46 capital, trust) (Angeon et al., 2006; Putnam, 1993; 2000; Woolcock, 1998). Nonetheless, geographical
47 proximity provides a framework for integrating space into interactions, which makes the approach by
48 the proximities more interesting for our study (Polge, 2015).

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

55 carried out on organizational processes and dynamics that accompany the implementation of territorial
56 food governance. This kind of governance refers to forms of coordination allowing the various food
57 actors of a territory, understood as “a developed space, socially constructed, culturally influenced and
58 institutionally regulated” (Lopez and Muchnik, 1997), to take part in collective action promoting
59 territorial resources (Fournie, 2016). Some rural studies associated the social network approach with
60 the proximity analysis. This was the case in situations of dynamics of changes and innovation, i.e.
61 among cereal growers in Burgundy reducing use of phytosanitary products (Compagnone and Hellec,
62 2015), among banana growers in Guadeloupe implementing agroecological practices (Houdart et al.,
63 2011) or among dairy producers in Brazilian Amazon region in a context of environmental and
64 technical pressure (Torre et al., 2018). Other rural studies apply these two frameworks to analyze local
65 processes of economic development in Brazilian Amazon (Polge et al., 2016), or to study the
66 relationship between individuals' dwelling unit locations and their kinship relations in Thailand
67 (Verdery et al., 2012). The present article will complement this research, using both frameworks to
68 enrich the reflections on collective action in LAS, more specifically focusing on the interactions
69 between different actors (producers, extension agents, inspection veterinarians and local authority)
70 within a collective organization, who committed to a process of defense and certification of a
71 traditional mountain cheese in southern Brazil.

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

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

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

96 - First, a social network approach seeks to understand how patterns of interactions among actors frame
97 collective action in the association (Lazega, 2014). Additionally, the social network approach gives
98 information on the role of each actor in the network and enables to see if some actors have more
99 influence on collective action (Crona et al., 2011), particularly in terms of status. Here, two types of
100 status are considered, the formal status in terms of formal position identified by higher socio-economic
101 attributes (i.e. education, revenue), and the informal status which reflect the position of the individual
102 in the network in terms of indegree centrality (number of advice request received) (Lazega et al.,
103 2012). We will describe the advice network concerning farming and cheese making matters, thanks to
104 data collected through sociometric interviews based on the roster method with the producer members
105 of the association (Wasserman and Faust, 1994). For that, we showed the roster of all the actors
106 involved in the association to forty-six of the forty-seven producer members so that they cite the
107 names to whom they seek advice. We only asked the producers and not the other participants
108 (extension agents, inspection veterinarians and agricultural secretaries) because advice seeking on

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

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

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

129 **2. Conceptual frameworks**

130 **2.1. The concept of Localized Agrifood Systems**

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

136 model, integrating the notion of sustainability and territory (Fournier and Touzard, 2014; Muchnik et
137 al., 2007). More particularly, LAS focus on the relations between food identities and productive
138 techniques, between preservation of territorial resources and qualification of the products and between
139 agriculture and other uses of the rural territory (i.e. tourism). Nowadays, the concept has spread to the
140 international community. In particular, a European research group (GDRE) and a research and
141 development network in Latin America working on LAS were created (Muchnik and Sainte Marie,
142 2016).

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

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

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

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

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

165 **2.2. Territorial proximity as element of understanding collective action in LAS**

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

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

181 Second, organized proximity concerns the different ways for actors to be close, outside the
182 geographical relationship. The term “organized” refers to any structured set of relationships without
183 prejudging the form of the structure (e.g. firms, community). It corresponds to the ability of an
184 organization to interact with its members (Bouba-Olga and Grossetti, 2008). The organized proximity
185 is based on two essential, but not incompatible logics: the belonging and similarity logics (Torre,
186 2010).

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

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

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

201 Geographical and organized proximities are neutral in their essence, they carry potential in terms of
202 interaction and organization but can remain unexploited if they are not activated (Pecqueur and
203 Zimmermann, 2004; Torre and Beuret, 2012). The combination of them constitutes a powerful factor
204 of territorial governance, which allows to overcome conflicts and misunderstandings, but also to bring
205 together agents who did not know each other or who led uncoordinated actions (Torre and Beuret,
206 2012).

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

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

217 The proximity approach integrates the concept of social capital in the sense of Putnam, who defined it
218 as "features of social organizations, such as networks, norms and trust and facilitate action and
219 cooperation for mutual benefits" (Putnam, 1993). More precisely, organized proximity includes the
220 bonding and linking dimensions of social capital, as well as trust (Angeon et al., 2006; Putnam, 2000;
221 Woolcock, 1998). Indeed, the bonding dimension operates according to the similarity logic whereas
222 the linking dimension operates more according to the belonging logic (Angeon et al., 2006; Polge,
223 2015). The approach by geographic proximity, in turn, provides a framework for analyzing
224 interactions between actors located in a territory (Polge, 2015). In our study, we chose to use the
225 proximity framework to consider simultaneously the organizational dimension and the spatial
226 dimension in the analysis of social interactions.

227 **2.3. Advice in agriculture**

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

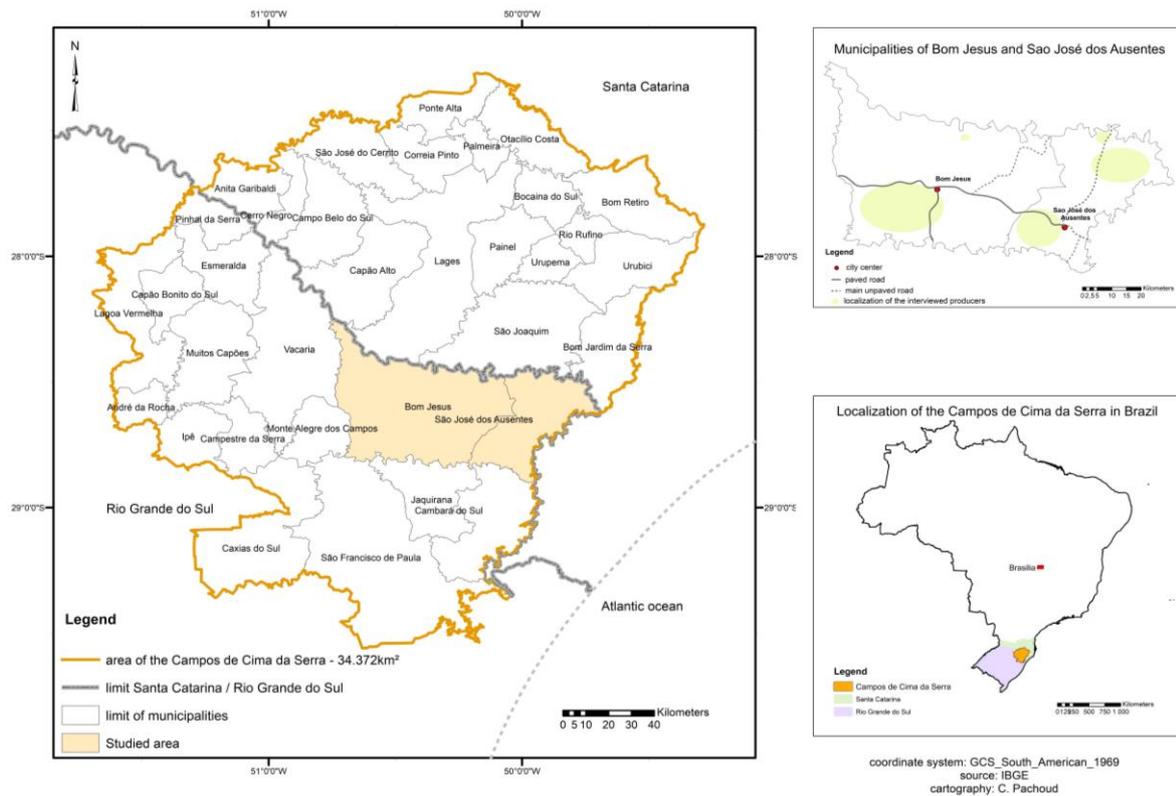
242 et al., 2011). This approach addresses local norms and social positions of individual within the social
243 structure. In fact, members of a farmer group do not have the same opportunity to interact and any
244 attempt to influence the group must take into account the structure of relationships and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

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

254 **3. Materials and Methods**

255 **3.1. The artisanal Serrano cheese**

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



261
 262 **Fig. 1: Localization of the Campos de Cima da Serra and the municipalities of Bom Jesus and São José dos Ausentes.**
 263 **(For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this**
 264 **article.)**

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

277 However, cheese production is faced with administrative constraints. During the era of agri-food
278 modernization in the 1950s, a law came into force¹ which prohibited the marketing of raw milk cheese
279 with less than sixty days of maturation. The regulation aimed at standardizing production processes
280 and hygiene standards and was designed under the pressure of food industries, disregarding artisanal
281 production. Public institutions did not provide any support to producers to adopt standards and did not
282 determine program aiming at preserving cultural traditions of artisanal row milk cheeses (Cruz, 2012).
283 Today artisanal raw milk is gaining in recognition (Vitrolles, 2011). However, food industry puts
284 pressure on public institutions to slow down the implementation of a regulatory framework on
285 artisanal raw milk cheeses in order to restrain economic competition (Cruz, 2012; Sgarbi, 2014).
286 Most of Serrano cheese producers do not respect the restriction of minimum maturation because
287 consumers prefer young cheese over matured one, and hence sell their produce within less than thirty
288 days, which makes the sales illegal. Moreover, the sanitary norms in Brazil for dairy products do not
289 consider the specificities of artisanal production, which are subject to the same sanitary standards and
290 facilities as big dairy industries. Thus, making it impossible for small scale farmers to comply because
291 of the high costs of adaptation (Cruz, 2012). Today, there are two kinds of certification authorizing the
292 marketing of Serrano cheese but only for mature cheese, ripened for more than sixty days. First, the
293 certification delivered from the municipal inspection service (SIM) authorizes the marketing of
294 Serrano cheese within the area of the municipality. The inspection veterinarians employed by the
295 prefectures of the municipalities control the health of the herd and the adequacy of the infrastructures.
296 Only eighteen families have the SIM certification within the Campos de Cima da Serra. Second, at the
297 state level, the law n° 14,973 and the decree n° 54.199 which legalize the commercialization of
298 artisanal Serrano cheese were approved respectively in December 2016 and August 2018 (State of Rio
299 Grande do Sul 2016, 2018). However, no producer has yet obtained the state certification. At the
300 federal level, there is no legislation authorizing the Serrano cheese sales in the country. Nonetheless,
301 producers claim that the high standards have a negative impact on artisanal characteristics of the
302 cheese, for example, as they are required to replace wooden molds with plastic ones. Besides, the
303 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-RS², 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.

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

335 **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

336 Infrastructures are little developed in the two municipalities. There are only two paved roads. The only
 337 means of transportation are private cars. The access to phone and internet is limited; the network only
 338 covers in the city centers and along the paved roads. Families of producers are isolated. Table 3 shows
 339 average distances from the farm to neighbors, city center and paved road of the forty-six interviewed
 340 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 information³. 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

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

422 3.2.4. Social network analysis

423 We analyzed two networks: the advice network including the formal and informal advice relationships
424 and the advice network of the informal advice exchanges between peers after removing the formal
425 advice. For that, we used two kinds of approaches. First, the positional approach that aims at
426 characterizing the position of each individual in the network using indicators. Second, the structural
427 approach that aims at characterizing the network's structure at different scales: i. global, using
428 indicators and an algorithm for communities' detection, and ii. local, using ERGM's to analyze
429 connectivity patterns between pairs or triads of nodes. These analyses were conducted with R version
430 3.5.1 using the series of extensions dedicated to network analysis: igraph for descriptive measures
431 (Csardi and Nepusz, 2006) and statnet for ERGMs (Handcock et al., 2008).

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

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

455 Last, in order to control for the effects of endogenous and exogenous processes in shaping the advice
 456 network, we used ERGM (Exponential Random Graph Model). ERGM was implemented on the
 457 directed network including the formal and informal advice in statnet to quantitatively analyze the
 458 networks' structure. These models allow testing if the structure of the observed network differs from
 459 what would be expected if relationships were established randomly, and to further detect which
 460 variables contribute to explain its structure. These variables can be of two kinds: endogenous, i.e
 461 network-dependent effects reflecting processes of self-organization and exogenous and directly linked
 462 with the structure of the studied network, i.e linked to the attributes of the nodes, reflecting the formal
 463 status of the producers (Lazega et al., 2012) and to independent dyadic phenomena (Lusher et al.,
 464 2012; Robins et al., 2007). We list in Table 4 all the variables selected and the associated hypothesis
 465 concerning social processes involved in ties establishment.

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

	Terms	Process	Hypothesis
--	-------	---------	------------

Structure variables (endogenous)	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 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)	

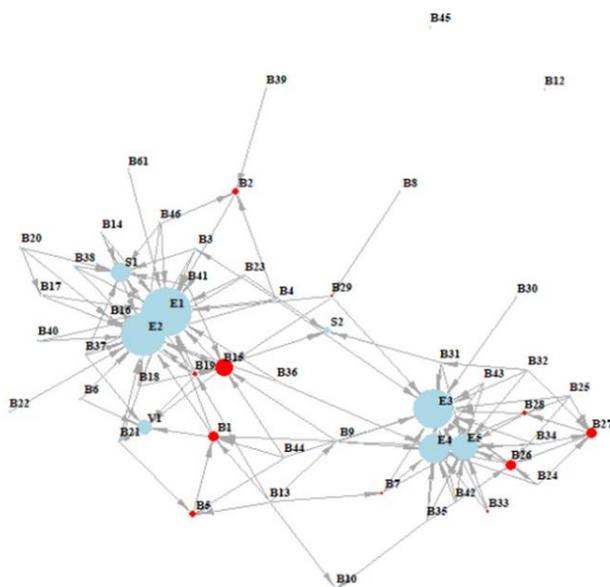
	Organized proximity	Church (node attribute)	Masse participation	Participation to cultural celebrations increases the likelihood to be sought for advice
		Rodeo contest (node attribute)	Rodeo contests participation	
		Gaicho fest (node attribute)	Gaicho fests participation	

467 **4. Results**

468 **4.1. Social network analysis**

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

Nodes	54
Links	135
Density	0.05



Legend

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

472 **Fig. 2: Network including formal and informal advice of the APROCAMPOS association. (For interpretation of the**
 473 **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	59.3
	Inspection veterinarians	4.4
	Secretaries of agriculture	8.1
	Total of formal advice ties	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.

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

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

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

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

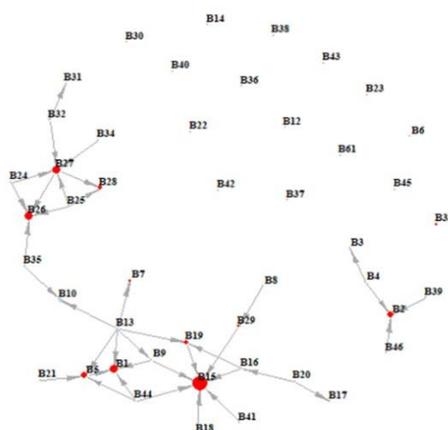
500 Concerning the inspection veterinarians, they interact only with legalized producers or those who want
 501 to start the process of legalization. It is the reason why only twenty-nine of the forty-six families could
 502 not assess their trust level as they do not work with inspection veterinarians.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

510 Last, the relationships between the agricultural secretaries and the producers are much more
 511 contrasted. Indeed, twenty-nine families of producers qualified the trust level with the agricultural
 512 secretaries from good to high, sixteen as medium to low and one did not answer. However, many
 513 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.)

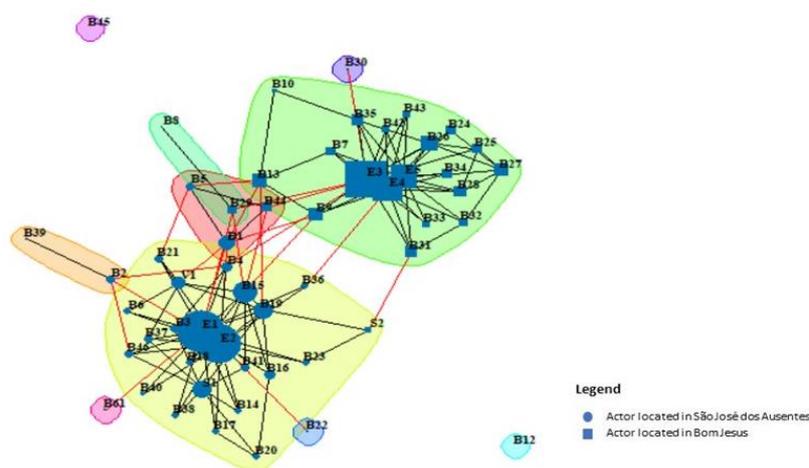
520 When focusing on the informal advice network for positional indicators (Fig 3.), we observe that the
 521 producer with the highest indegree, it means the most popular and prestigious producer among peers,
 522 is the president of the association (indegree=7). B1, B26 and B27 have also, in a less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

523 indegree (indegree=4). These four central producers have the SIM certification. Moreover, B1, B15
524 and B26 are part of the board of direction (B15 is the actual president and B1 was the first president).
525 This result show that these four popular producers, having a SIM certification and being members of
526 the board of direction, have a higher formal and also informal status for advice among peers.
527 Considering the betweenness centrality, we observe that the values are low. B27 has the highest
528 betweenness centrality, equal to 5. This producer, who is SIM certified, is giver and receiver of advice.
529 Otherwise, betweenness centrality is equal to 0 for forty producers and it is comprised between 0.5 and
530 2 for five producers. Moreover, we observe that producers only cited thirty-eight times another
531 producer, it means 28.1% of the total advice seeking ties (Table 5). This demonstrates a low advice
532 flow among peers. This observation supports the trust assessment between the producers in which low
533 trust level among producer families (Table 6). Latent conflicts were also identified, especially among
534 certified and non-certified producers. The first ones claimed that (i) the non-certified do not respect the
535 hygiene standards which represented a danger for the consumers and affected the image of the
536 producers using good practices; and that (ii) they sell to a lower price which leads to a price decrease
537 for the certified producers. On the other side, many non-certified producers claimed that the legalized
538 ones do not produce traditional cheese anymore, because of the standards that change its
539 characteristics. Also, there were jalousie feelings. Some producers claimed that some certified
540 producers are favored by the extension services and the inspection services, applying less exigent
541 standards. Moreover, results indicate that 43% cited extension agents in first position, then 33% of the
542 producers cited the nuclear family (not included in the result as intrafamily ties are not analyzed), but
543 only 13% cited other producers at the first place. This information cannot be integrated in the
544 quantitative analysis but appeared important to show the lack of advice exchange between families.

545 4.1.2. Structural indicators

546 Concerning the structural indicators on the advice network including all the actors of the association
547 (formal and informal advice) (Fig 2.), we observe that the density is low (0.05) because the mean
548 number of ties established by producers is low (2.9 per producer; SD=1.5). The network is centralized,
549 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.).



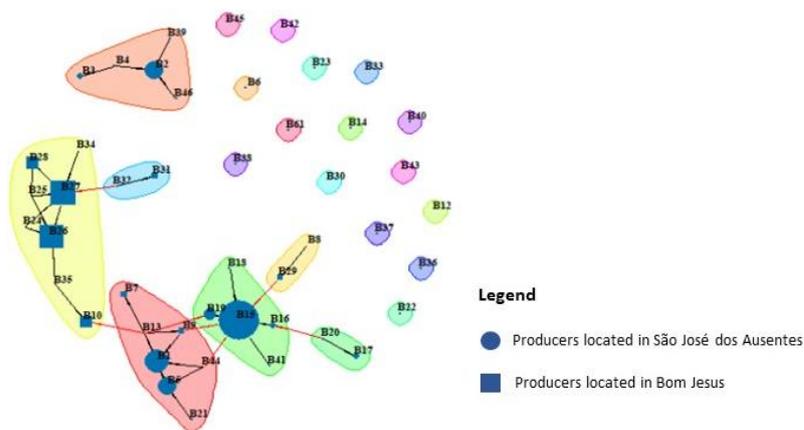
559
 560 **Fig. 4: Community repartition on the network including formal and informal advice of the APROCAMPOS association. (For**
 561 **interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)**

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

570 communities (red and orange) are located in the southeast of the study area, one community (yellow)

571 in the southwest and one other (green) in the northeast. Nonetheless, the network is sparse with many

572 isolates (fifteen families) and three dyads formed between neighbors at the periphery.



573

574 **Fig. 5: Community repartition on the informal advice network among peers of the APROCAMPOS association. (For**

575 **interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)**

576 4.1.3. Statistical analysis on the advice network

577 The results of the final model for statistical analysis on the directed network including formal and

578 informal advice is presented in Table 7.

579 **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
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580 Parameter estimates are expressed in log-odds with their standard deviation (SD) in parentheses. * $P < 0.05$; ** P
581 < 0.01 ; *** $P < 0.001$

582 ERGM results first showed that the distribution of the edges in the network was unlikely to be due to
583 chance as the edge effect was significant (-1.59; $p < 0.001$). The best model with respect to the AIC
584 retained endogenous variables and attributes reflecting socio-economic status of the producers,
585 geographical and organized proximities presented in Table 7. Goodness of fit results are presented in
586 Appendix. Concerning the endogenous variables, transitive closure effect was significant (0.81;
587 $p < 0.001$), indicating that producers were more likely to establish ties if they had common exchange
588 partners. Correlatively, the significantly negative estimate for multiple connectivity indicated that
589 untied actors have a lower probability to have common partners than at random for advice seeking (-
590 0,52; $p < 0.001$). The conjunction of a positive triad closure effect (GWESP) accompanied by an
591 absence of cyclical triad, showed previously with igraph package, demonstrate that triads are
592 transitive. It means that there is a local hierarchy by a concentration of leadership in advice toward
593 individual of higher formal or informal status.

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

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

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

685 Furthermore, the qualitative analysis showed that producers stay in their families and rarely move.
686 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).

713 Then, effects of endogenous and exogenous processes had a role in shaping the network including
714 formal and informal source of advice. The significant over-representation of triad closures in the
715 networks highlighted by ERGMs results and the absence of cyclic triads defined by igraph package
716 showed that triads are transitive. This demonstrated a local hierarchy in advice, which indicates that
717 some actors have a certain authority linked to their formal or informal status (Lazega et al., 2012). In
718 fact, the actor seeking advice acknowledges the status of the advisor, which may be informal or
719 formal. Here it is clear that extension agents have the most prestigious informal status for advising, as
720 they have the highest indegree centrality. They enjoy also a higher formal status considering the
721 revenue and the educational level, compared to family farmers. Nonetheless, producers of higher
722 formal status, represented by a higher diploma, a higher intensive production system and a higher
723 cheese selling price, tend to be more sought for advice. Studies have shown that status-differentiated
724 groups will tend to be more successful in collective action. Status acts as a coordination mechanism:
725 members of higher status initiate collective action and contribute at higher levels and influence those
726 of lower status to follow with larger contributions (Berger et al., 1977; Simpsons et al., 2012; Willer,
727 2009).

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

740 2012). Several levers exist to favor interaction occasions between actors who would not necessarily
741 meet otherwise. Polge and Torre (2018) demonstrated that in two public policy arrangements in the
742 Brazilian Amazon, great distances between actors made their interactions difficult but not impossible.
743 For that, the improvement of the infrastructures and punctual support for the cost of transport were
744 applied to facilitate the translocation and to increase temporary geographical proximity. Moreover,
745 geographical proximity needs to be crossed with organized proximity to develop interactions. Indeed,
746 participation in cultural life (e.g. rodeos contests) allows increasing the interaction opportunity.
747 However, cultural events do not occur often, for example, masses happen once a month and gaucha
748 fests only few times a year, which do not provide many opportunities for encounter. The association
749 meetings are the best way to increase interactions and trust between producers. Similarly, other
750 initiatives undertaken by extension agents, such as cheese contests and courses offered to improve
751 production allow the development of new spaces of interaction. At the end, increasing interaction
752 would eventually lead to higher trust between the producers (Crona et al., 2011). Nonetheless, the
753 construction of a belonging logic of organized proximity needs to exceed the level of sole participation
754 of local actors of the Serrano cheese value chain (producers, extension agents, inspection veterinary).
755 The development of interactions at an upper-level (inter-municipality, state or federal level) through
756 the construction of institutional arrangements are crucial (Polge et al., 2016). In fact, the Serrano
757 cheese represents an important specific resource for the territorial development which needs
758 implementations of specific policies to achieve quality standards and qualification (Colletis and
759 Pecqueur, 2004). Also, cooperation with other territorial actors, among others tourist operators, seems
760 highly recommendable. These are instrumental conditions for favorable territorial food governance
761 frameworks to implement common projects of development.

762 However, three limitations of this paper need to be mentioned. 1) The inclusion of formal institutions,
763 especially extension services, has certainly reduced the number of advice ties that could have occurred
764 within peers. Indeed, giving technical advices for the extension agents is a part of their job.
765 Nonetheless the focus of this study are collective dynamics within the association. That is why it was
766 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.

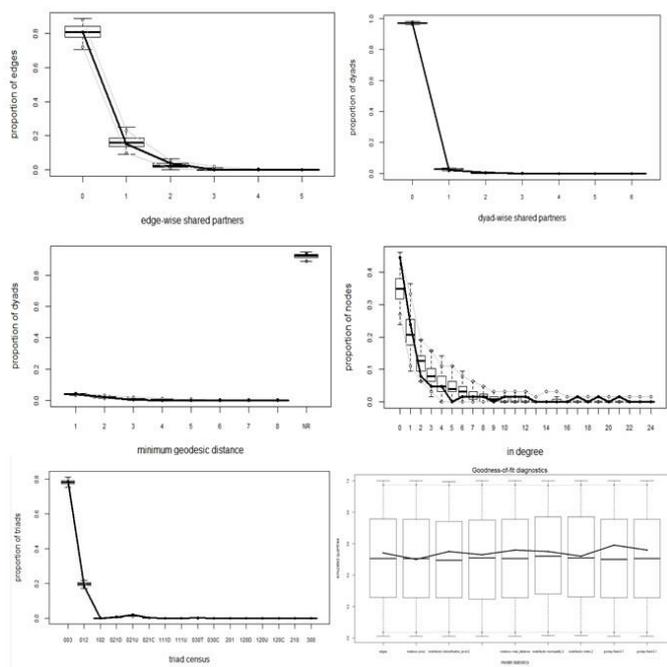
789 In conclusion, a top-down model leads to low level of initiative and participation of the producers in
790 collective action. Local actors need to build common projects together for the valorization of the
791 Serrano cheese in order to master their own model of development. For that, they require 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

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

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804 Appendix. goodness of fit results for directed advisory network



805
 806 **Figure A: goodness of fit results for edge-wise shared partners, dyads wise shared partners, minimum geodesic distance,**
 807 **indegree and triad census parameters and for the statistical model for directed network including formal and informal**
 808 **advice (see Hunter et al., 2008).**

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