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► To cite this version:

Ronan Le Velly, Marc Moraine. Agencing an innovative territorial trade scheme between crop and livestock farming: The contributions of the sociology of market agencements to alternative agri-food network analysis. Agriculture and Human Values, Springer Verlag, 2020, 10.1007/s10460-020-10026-8 . halshs-02573572

HAL Id: halshs-02573572

<https://halshs.archives-ouvertes.fr/halshs-02573572>

Submitted on 14 May 2020

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Agencing an innovative territorial trade scheme between crop and livestock farming: The contributions of the sociology of market agencements to alternative agri-food network analysis

Ronan Le Velly*, Marc Moraine

* Corresponding author

Abstract

The aim of this article is to show the relevance of the sociology of market agencements (an offshoot of actor-network theory) for studying the creation of alternative agri-food networks. The authors start with their finding that most research into alternative agri-food networks takes a strictly informative, cursory look at the conditions under which these networks are gradually created. They then explain how the sociology of market agencements analyzes the construction of innovative markets and how it can be used in agri-food studies. The relevance of this theoretical frame is shown based on an experiment aimed at creating a local trade scheme between manure from livestock farms and alfalfa grown by grain farmers. By using the concepts of the sociology of market agencements, the authors reveal the operations that are required to create an alternative agri-food network and underscore the difficulties that attend each one of these operations. This enables them to see the phenomena of lock-ins and sociotechnical transition in a new light.

Keywords

Actor-network theory, Agroecology, Alternative agri-food networks, Crop-livestock integration, Marketization, Innovation

Abbreviations

FNAB: Fédération Nationale de l'Agriculture Biologique (French National Federation of Organic Agriculture)

GAB: Groupement d'Agriculture Biologique (Organic Agriculture Group)

INRA: Institut National de la Recherche Agronomique (French National Institute of Agricultural Research)

Contact information

Ronan Le Velly, UMR Innovation, Univ. Montpellier, Cirad, INRAE, Montpellier SupAgro
2 place Viala, 34060 Montpellier, France, levelly@supagro.fr, Orcid ID 0000-0002-7334-3157

Marc Moraine, UMR Innovation, Univ. Montpellier, Cirad, INRAE, Montpellier SupAgro
2 place Viala, 34060 Montpellier, France, marc.moraine@inrae.fr, Orcid ID 0000-0001-5443-4283

Authors biographies

Ronan Le Velly is professor of sociology in Montpellier SupAgro and member of the UMR Innovation. His research is at the crossroads of market sociology and rural studies and focuses on alternative agri-food networks such as fair trade, short food supply chains, and organic agriculture.

Marc Moraine is researcher in agronomy in the French National Research Institute for Agriculture, Food and Environment (INRAE) and member of the UMR Innovation. His research in agronomy and agroecology focuses on crop-livestock integration and farming systems' diversity and complementarity at the territorial level.

Acknowledgements

The authors thank Frédéric Goulet, Jérémy Forney and the participants of the New directions in agri-environmental governance workshop in Neuchatel, and the two AHV reviewers for their comments on an earlier version and Gabrielle Leyden for her translation. This research has been funded by the French National Research Agency (grant ANR-15-CE21-0006 'Institutionnalisation des agroécologies').

Introduction

Research into alternative agri-food networks, which began in the late 1990s, now makes up a substantial body of work in the field of rural studies (Goodman et al. 2012). This research has focused since its beginnings on the “alternativeness” of initiatives such as organic farming, fair trade, local produce, and short food supply chains. The initial aims of such research were to underscore the fact that these approaches could be answers to the many injustices in the dominant agri-food system (Kloppenburger et al. 1996; Renard 1999) and lay the foundations for a new rural development model (van der Ploeg et al. 2000; Renting et al. 2003). The researchers then delved deeper and went farther afield by looking at the phenomena of hybridization (Ilbery and Maye 2005) and conventionalization (Guthman 2004). So,

alternative agri-food networks were no longer seen as separate worlds functioning totally independently and differently from conventional networks. Instead, their practices were acknowledged to be partly alternative and partly conventional (Hinrichs 2003; Kneafsey et al. 2008) and to face various difficulties maintaining their alternativeness, due in particular to the pressure exerted by players from conventional networks (Raynolds et al. 2007; Jaffee and Howard 2010). To account for these phenomena of hybridization and conventionalization, the researchers worked on the actors' characteristics, for example, to determine whether organic farmers' motivations were different from those of conventional farmers and whether these motivations differed between pioneers and newcomers (Hall and Mogyorody 2001; Lockie and Halpin 2005; Best 2008). They also worked on the ways that alternative agri-food networks were organized, putting emphasis in particular on the roles of standards and certification (DuPuis and Gillon 2009; Raynolds 2009; Fouilleux and Loconto 2017) or showing the importance of processing and distribution infrastructures (Klein 2015; Clark and Inwood 2016). Finally, some of these studies led to analysis of the connections between alternative agri-food networks and the agri-food system's dominant operating patterns. They then described the lock-in and transition phenomena that could be observed through the theoretical framework of Geels's multi-level perspective (Geels 2004; see in particular Wiskerke 2003; Bui et al. 2016) and discussed the close ties between alternative initiatives and the dominant neo-liberal regime (Allen and Guthman 2006; Laforge et al. 2017).

This necessarily quick and incomplete overview attests to the diversity and richness of the work done to date. Yet, we noticed one thing on which relatively little research has been done, namely, how alternative agri-food networks are created. The aforementioned investigations often include sections relating the histories of the initiatives being studied, but these histories are only contextual elements required for the reader's comprehension. However, special stakes ride on working on alternative initiative creation processes. Michel Callon and Bruno Latour's sociology of innovation is instructive in this regard (Callon 1986, 1987; Latour 1987; Akrich et al. 2002; see also Kristensen and Kjeldsen 2016). It shows that creating a new product or organizational scheme requires a considerable mass of operations going from the definition of the problems to solve to the recruitment of allies in different social worlds, with the construction of prototypes in between. These creation phases are marked by uncertainty, for example, regarding how the technology will perform or consumers will behave. Only little by little does the action stabilize around rules and identities that become "black boxes" and are no longer challenged. What is more, the innovation process very often does not end in this stabilization, but in failure or abandonment. Whereas a retrospective report centered on

successful innovations tends to lose sight of the uncertainties and difficulties encountered, the monitoring of innovations “in the making” that Callon and Latour promote makes it possible to grasp all the complexity of these processes.

In this article we shall place ourselves in this vein of work. We shall show that economic sociology research, which we refer to under the term “sociology of market agencements” and of which Callon is a key protagonist (Callon 1998; Callon et al. 2002; Çalışkan and Callon 2010) allows in-depth analysis of the creation of alternative agri-food networks. This research has grown considerably over the past ten years and been the subject of numerous publications, especially in the form of special issues and collective works (Cochoy and Dubuisson-Quellier 2000; MacKenzie et al. 2007; Muniesa et al. 2007; Geiger et al. 2014; Cochoy et al. 2015; Kjellberg et al. 2015; Cochoy et al. 2016). Since just recently it has also been used to study agri-food networks, especially to reconstitute situations of innovation (Miele and Lever 2013; Ouma et al. 2013; Buller and Roe 2014; Hébert 2014; Ouma 2015; Le Velly and Dufeu 2016; Phillips 2016; Henry 2017; Henry and Prince 2018; Wang 2018, 2019). We shall thus devote a large part of this article to presenting this work.

This article will also make use of a particularly rich and original case study, that of an experiment that we conducted in Tarn-et-Garonne (France) aimed at creating a system of exchanges of manure and crops from livestock and grain farmers. The complementarity between cropping and livestock farming that has existed on farms for centuries is currently declining in France (Chatellier and Gaigné 2012). The modernization of agriculture has given rise to the spread of highly specialized farms that rely on chemical inputs. That has generated countless problems for the farmers (especially when it comes to controlling pests and maintaining soil quality) and environmental problems that are just as alarming (for example, the pollution of water by nitrates in areas heavily specialized in livestock) (Peyraud et al. 2014). One way to handle these crises is to reinstate a more agroecological model combining multicropping and livestock farming on these farms. However, many farmers deem transitioning to this model impossible because of the investments that must be made and skills that must be acquired (Meynard et al. 2013). An original way to overcome this hurdle is thus to create trade schemes between the livestock and crop farmers from the same area, whereby the former provide the latter with manure and slurry and the latter provide the former with feed for their livestock (forage, straw, and meslin). In this article we propose to consider such trade schemes alternative agri-food networks. That may be surprising, since these initiatives do not involve food consumption by humans. Yet they share the core characteristic of the alternative agri-food networks that are usually studied by researchers, namely, the ambition of

establishing renewed production, exchange, and/or consumption relations that correct conventional agri-food networks' perceived malfunctions.

The rest of the article will be organized as follows: In the first part, we shall present the theoretical framework of the sociology of market agencements, stressing the way it can be used to study innovation in agri-food networks. In the second part we shall present the methodology of the experiment in which we engaged to build the territorial network of livestock and crop farmers in Tarn-et-Garonne. We shall see that this experiment was not a total success and did not culminate in a scheme of true exchanges between livestock and crop farmers. Far from weakening our arguments, this finding bolsters our idea that the creation of alternative agri-food networks is a difficult operation, the process of which deserves thorough analysis. Indeed, we shall perform this analysis in the third part of the article. In referring to the main concepts of the sociology of market agencements we shall describe the various operations that are required to create a new agri-food network, namely, identifying “overflowing” that justifies new “framings,” defining the quality of the goods involved, producing references for “qualculation,” organizing the “market encounter,” setting prices, and finally “attaching” the actors to the new network. This will enable us to come back, in the conclusions, to the contributions that the theoretical framework makes to analyzing alternative agri-food network creation. We shall stress how it renews the ways sociotechnical lock-ins are analyzed.

The sociology of market agencements: a theoretical framework for analyzing agri-food network creation

A concern for innovation processes

The sociology of market agencements, inspired by the science and technology studies, pays particular attention to the innovation processes in markets. It is meaningful that Callon's research focuses on the “marketization” processes that allow markets' creation rather than on markets as already constituted objects (Çalışkan and Callon 2010). The same can be said for the articles that underscore the importance of analyzing the “agencing of markets” (Onyas and Ryan 2015; Cochoy et al. 2016), “market work” (Cochoy and Dubuisson-Quellier 2000; Mason et al. 2017), “market design” (MacKenzie 2009), or “market innovation” (Kjellberg et al. 2015). The vocabulary changes from one text to the next, but the desire to understand how new markets take shape remains.

The study of marketization processes has two goals. The first one is to underscore the mass of operations necessary for markets to form. In applying the sociology of market agencements to

analyze the development of mango export markets in Ghana, Stefan Ouma and his colleagues write that this work makes it possible to “de-essentialize markets, unveil their often messy and compromised construction from below, and reconstruct the diversity of legitimate arrangements that finally evolve from the encounters of a diverse range of market makers” (Ouma et al. 2013, p. 234). This finding is borne out in other studies mobilizing this sociology. The fragility or failures of innovation processes are thus underscored convergently for the construction of lettuce export markets between Taiwan and Japan (Wang 2018), development of tools to identify products that respect animal welfare (Miele and Lever 2013), and shifts in the operations of a commercial salmon fishery in southwest Alaska (Hébert 2014). As the end of the preceding quotation already attests, the second aim of studying marketization processes is to put emphasis on the very great diversity of actual markets that can result from market formation processes. Marketization can thus be motivated by very diverse ends. For example, it is possible to test new market agencements to reduce greenhouse gas emissions (MacKenzie 2009) or improve the accessibility of health for all (Geiger and Gross 2018).

When it is applied to agri-food studies, the sociology of market agencements thus enables one to challenge the stable ontologies of the market, economy, or capitalism that can be observed in economics but also in critical political economy (Ouma 2015; Henry and Prince 2018). This is not new, either: It already happened with Actor-Network Theory (ANT), which inspired the sociology of market agencements (Busch and Juska 1997). Seen in this way, the market cannot be defined as the impersonal, self-seeking, competitive space that has come in for as much praise from neoclassical economists as denunciation by the critics of commodification. “Markets organize the conception, production and circulation of goods, as well as the voluntary transfer of some sorts of property rights attached to them,” Çalışkan and Callon write more openly (Çalışkan and Callon 2010, p. 3). This definition does not rule out the possibility that actual markets may take the form of neoclassical economic models (Callon 1998), but it does not exclude their taking any other form, either. Note as well that the scope of the definition includes the conception and production of goods. To understand why, it is useful to clarify the link with ANT.

The connection with Actor-Network Theory

ANT (for an introduction, see Latour 2005) has inspired the sociology of market agencements strongly. This is particularly true for three of its major teachings.

The first one concerns taking non-human entities into account in analyzing marketization processes. The sociology of market agencements has thus put great emphasis on the action of what it calls “market devices” (Muniesa et al. 2007). The creation of new markets and their ability to achieve the ends that their promoters give them depend on material devices such as standards and labels, logistic infrastructure and points of sale, mathematical algorithms and quality assessment guides, and so on (Karpik 1996; Kjellberg and Helgesson 2007; Cochoy 2008). The problem for rural studies is then to grasp the “materiality” of agri-food markets. The sociology of market agencements is close in this respect to the studies that have shown the impacts of standards and labels (Raynolds 2009; Fouilleux and Loconto 2017) and the importance of distribution infrastructure (Ilbery and Maye 2005; Klein 2015) in alternative agri-food networks. However, in taking up the matter of materiality systematically, it also makes it possible to look at other market devices, the importance of which is less well known, such as packaging (Phillips 2016), charts of price lists (Henry 2017), displays urging farmers to save (Onyas et al. 2018), and so on.

A second set of non-human entities must be spotlighted, namely, natural entities. To tell the truth, these entities are less present in marketization research than material devices are. Yet, when it comes to agri-food markets, attention must be paid to them. In taking the actions of these natural entities into account, the sociology of market agencements, like ANT more generally, sheds an original light on things compared with other theoretical frameworks used in rural studies (Goodman 1999; Dwiartama and Rosin 2014; Henry 2017; Wang 2019). Agricultural crops, be they animal or vegetable, are living things that cannot be marketed willy-nilly: they are usually seasonal; they are perishable, if not hazardous when improperly stored; and they are characterized by greater variability and unpredictability than industrial products (Bernard de Raymond et al. 2013). In ANT terms, they act, they impact marketization. The actions of other natural entities, such as insects and bacteria, are also vital, to the point that their behavior must often be kept in check to succeed in creating a market. It is not by chance that rural studies articles referring to the sociology of market agencement so frequently underscore the importance of packing that keep produce cool or refrigerated transport infrastructure (Ouma 2015; Le Velly and Dufeu 2016; Phillips 2016; Henry 2017). These objects, which could seem insignificant, occur at the intersection of the actions of the human beings (who produce the devices), material devices (which keep the food’s properties intact), and natural entities (which must be channeled).

The second teaching, which has already been affirmed in science and technology studies (Callon 1987; Akrich et al. 2002), is that market innovation is a process that creates supply,

demand, and the market in the same movement. The human and non-human entities that slip in between the producers and consumers act as “mediators” (Latour 2005) that modify these two opposite ends of the network. The emphasis is then put on all the operations, such as taste tests for food products, by means of which the supply adjusts to what it perceives to be the demand (Callon et al. 2002). Even more obvious examples are those of guidebooks such as the *Michelin Guide* and purchasing guides drafted by environmental groups, which act on the demand by educating and equipping consumers but also act on the supply by establishing reference frames of practices that consumers are assumed to expect (Karpik 2000; Dubuisson-Quellier 2013). Talking about “market mediation” thus amounts to saying that market agencements are not simple meeting places between pre-existing blocs of supply and demand but sociotechnical arrangements, the different components of which define each other (Cochoy et al. 2016). When it is applied to the creation of alternative agri-food markets, this concept then enables one to underscore that producers’ characteristics and/or consumers’ expectations must not be considered to be prior givens for innovation, but rather elements that will be defined as the marketization process advances (Le Velly and Dufeu 2016; see also Lockie and Kitto 2000; Wang 2019).

The third teaching derives from the first two. Callon explains that he chose the French term “agencements” rather than “arrangement” because it is closer to “agency.” A market agencement is a sociotechnical arrangement that is capable of productive and market action (Çalışkan and Callon 2010). This presentation has the advantage of underscoring the distributed nature of agency: The ability to act is never restricted to humans alone. One implication of this is that understanding the motivations or attitudes of alternative agri-food networks’ actors, as is usually done in research (for example, Best 2008) does not suffice to understand their actions. The sociology of market agencements forces one to take the actions of the material devices and natural entities in the networks into account as well. What an alternative agri-food network is capable of doing to guarantee remunerative prices for farmers or improved welfare for livestock, for example, is the fruit of a network composed of human, natural, and material entities (Buller and Roe 2014; Le Velly and Dufeu 2016). Speaking of the agencing, as we do in the title of this article, thus means envisioning an operation that creates a new entity with the ability to act.

Six marketization processes

The sociology of market agencements has listed the operations that are required for agencing new markets with great care. Several proposals have been made in this regard (see, for

example, Kjellberg and Helgesson 2007). We, for our part, shall rely on the one made by Callon (Çalışkan and Callon 2010; Callon 2017), who breaks agencing down into six processes, which we shall present in four stages.

Çalışkan and Callon (2010) call the first process “pacifying goods.” Before being tradable, a good must acquire well-identified qualities that enable the market players to have expectations about its characteristics. This is particularly important for agricultural goods, which are biological entities characterized by great variety (Henry, 2017). Without standards for the generic characteristics of agricultural commodities or more specific qualities linked to one or the other option of sustainable agriculture, the large-scale trade in these commodities as we know it could not exist (Ouma 2015; Onyas et al. 2018). Symmetrically, we might add, a failure to design new quality standards hobbles the development of a new market (Miele and Lever 2013). The second process, which is closely linked to the first one, concerns the construction of “qualculating agencies.” The term “qualculation” was coined by Franck Cochoy (2008) to underline the continuity between operations of numerical calculus and qualitative judgment. For the sociology of market agencements, these two types of operation belong to the same logic of ranking things. Both are also the fruit of distributed cognition: Market players never do their computations alone; they do them with the cognitive equipment of their sociotechnical networks.

The third and fourth processes, namely, ensuring “market encounters” and “price setting,” are often linked. Research on financial markets has been particularly useful in revealing the agencing work that makes encounters between supply and demand and market price setting possible. It has shown in particular that economics has not just described these markets, but has done a great deal in recent years to configure them (MacKenzie et al. 2007; Muniesa et al. 2007). Ouma has likewise shown how the supply chain management approach – an operational application of critical research on global commodity chains – has supported and oriented the structuring of agricultural commodity export markets in the countries of the Southern Hemisphere (Ouma et al. 2013). The sociology of market agencements also leads to comprehension of the vital role of sales intermediaries. These actors, with their knowledge and infrastructure, do not just move products from production to consumption. They play a vital mediating role by enabling products to be available to consumers under good conditions, solving seasonality problems, guaranteeing compliance with quality standards, and so on (Le Velly and Dufeu 2016; Wang 2018). A device such as the price schedule setting a list of prices for various qualities of lamb in New Zealand is also a good example of this (Henry 2017). Matthew Henry shows that this device is central to the creation of a national and export

market for this type of meat, but he also shows the huge amount of work needed to design it as well as the controversies associated with its content.

The fifth process, which is absent from the text written with Çalışkan but was developed in Callon's 2017 book (and in Callon et al. 2002), concerns the way “attachments” between the sellers, their products, and their customers are created. This has been the subject of many articles, notably to understand how trade loyalties form and dissolve (Cochoy et al. 2015; Le Velly and Goulet 2015). Beyond this, other attachments are often necessary for new market creation. Depending on the case, the market's promoters must also convince banks to finance them, government authorities to change regulations, scientists to back the proposed changes, and so on (Kjellberg and Helgesson 2007; Doganova and Karnøe 2015; Mason et al. 2017). The attachment processes then strongly recall the processes of enrollment and mobilization such as they have previously been described in the sociology of innovation (Callon 1986; Akrich et al. 2002).

Finally, through the term “market maintenance,” Çalışkan and Callon (2010) stress that marketization is a process that combines stability and change (see also Kjellberg et al. 2015). The first five processes stabilize market relations, but they may be constantly challenged. In this connection, Callon stresses the centrality of the dynamics known as “framing” and “overflowing.” A market agencement is stable when the marketization processes under way are not controversial. Yet this situation is fragile nonetheless, for the qualities chosen to pacify goods, elements taken into account to “qualculate,” conditions of the market encounter, price-setting mechanisms, and established attachments are always partial and biased. They can then be the subjects of controversy and generate changes in the market agencements (Callon 2009; Miele and Lever 2013; Henry 2017). The desire to create alternative agri-food networks can moreover be analyzed as a will to contest the existing marketization processes. Highlighting instances of overflowing, as fair trade activists do when they call for fair payments for small farmers, boils down to challenging the framings that have been done. In other words, the introduction of new “concerns” leads their proponents to contest the stability of the existing market agencements (Geiger et al. 2014; Geiger and Gross 2018).

Methodology

A sociological analysis of an “in vivo experiment”

The case that we shall mobilize in the next part of this article is an *in vivo* experiment (Callon, 2009) to create a territorial system of exchanges between organic livestock and crop farmers in Tarn-et-Garonne (France). This experiment was conducted by the second author between

2013 and 2016 under a PhD thesis on which he was working at the French National Institute of Agricultural Research (INRA). His aim was by no means to test one or the other sociological analytical frame, but to work on designing ways to increase the territorial integration of crop farming and livestock operations. This is an issue that arose in agricultural research in the late 2000s (see Martin et al. 2016). The sociological analysis proposed in this article was thus done afterwards.

To do this analysis, the first author relied primarily on the second author's research reports. He then supplemented this data by conversing with the second author. The main limitation of this article is then that it is strongly influenced by the second author's experience and the first author's analytical grid. Regarding the first point, our approach can be perfected. It would have benefited from being bolstered by additional interviews to capture the players' feelings at the moment. It is nevertheless compatible with the methodological orientation of ANT, which gives priority to monitoring innovation process "in the making" ethnographically (Onyas et al. 2018). Let us also point out that experiments, whether in a laboratory or "*in vivo*," are classic subjects of ANT (Callon 1986; Kristensen and Kjeldsen 2016) and the sociology of market agencements (MacKenzie et al. 2007; Callon 2009). The methodology of this article belongs to this tradition for this reason as well. Regarding the second point, we take full responsibility for our choice of a specific analytical grid. Our aim is not to reveal various possible interpretations of this experiment, but to show the relevance of the sociology of market agencement to studying the creation of alternative agri-food networks. Describing in detail the steps and vicissitudes of this experiment will enable us to show how new ways of organizing agri-food networks develop and underscore the magnitude of the practical operations that this requires.

A four-step participatory design

Before proceeding with this analysis, we feel it is useful to give a quick description of the history of this experiment. It was initiated in 2013 by the second author, who was a PhD student in agronomy at the time, as part of a European research project involving several INRA researchers. It involved ten crop farmers and fourteen livestock farmers who were engaged in organic farming and belonged to Groupement d'Agriculture Biologique (Organic Agriculture Group) Bio 82 (GAB Bio 82), an association working to promote organic agriculture in Tarn-et-Garonne Department. These farmers volunteered to work with the researchers in order to think about developing close cooperation between their farms. The researchers' main aim was to contribute to the emerging field of research on territorial

integration between cropping and animal husbandry, with the secondary aim of developing tools that would be used by other groups of farmers. Finally, the investigators also felt it was important to implement participatory methods that would involve the farmers in order to integrate their objectives, preferences and constraints into the design process.

The first step in this participatory design exercise was to hold a workshop with all twenty-four farmers in order to determine the issues and goals to target. The researchers wanted to work on in-depth forms of collaboration between the livestock and grain farmers, but the actual forms that such collaboration would take was not set at the outset. This workshop first revealed that the livestock farmers and grain farmers were united in their desire to diversify and make their farms more self-sufficient. Yet, all of these farmers were also of the opinion that they could not envision developing mixed multicropping and livestock models on their farms due to a lack of skills and land (many were working small acreages that did not belong to their families). Next, the grain farmers explained that they found it interesting to add legume forage crops (alfalfa, clover, etc.) in order to improve soil fertility and further organic pest control, but did not do so because they had problems selling those crops. They also explained that the organic regulation-compliant fertilizers that they bought to fertilize their fields were very expensive and often of unknown origin. They thus thought that replacing them with manure coming from the neighborhood would make sense. The livestock farmers, for their part, likewise stressed that buying feed for their stock was very expensive in organic farming. What is more, feeding their stock with soybeans imported from other countries seemed to be highly inconsistent with the short supply-chain models that most of them were developing for their products. At the end of these exchanges the farmers in both groups agreed that it would be relevant to develop trade with each other, with stable prices and quantities that would enable them to plan their production levels.

In the second step, the doctoral student then took control to draw up a scenario that would make it possible to achieve these goals. To do that, he conducted individual interviews to determine each livestock and grain farmer's needs as well as what each would be willing to exchange within the group. Then, based on these findings, he did a computer simulation of a scenario that included (i) growing alfalfa and legumes on the grain farms, (ii) selling alfalfa to the livestock farmers, and (iii) producing composted manure on the livestock farms and selling it to the grain farmers. This scenario met the farmers' expectations and tied in with the researchers' knowledge: Adding alfalfa and manure to the grain farming systems adds nitrogen and organic matter to the soil, reduces the incidence of disease, and makes controlling weeds easier. Alfalfa, for its part, is a high-protein crop that can reduce reliance on

soybean cattle cake. Finally, composting manure facilitates its transport and reduces the risk of introducing the seeds of adventitious plants.

The aim of the third step was to discuss ways of organizing the exchanges. The PhD student proposed three main ways of organizing these exchanges (which we shall describe in the next section) at a half-day workshop with the farmers. The farmers weighed the pros and cons of each scheme, and then came to an agreement on the “polycentric model” and split up into several territorial subgroups tasked with finding practical solutions to ordering and delivery issues.

The fourth step in this participatory design phase was to do a multifactor evaluation of the sustainability that would result from the new organization of farming and trade. To do this, the PhD student and farmers agreed on an analytical grid containing five fields: the metabolic efficiency of the system, the production of ecosystem services for agriculture, socioeconomic performance, increases in the farmers' knowledge, and the social and territorial embeddedness of the farming operations. A series of indicators was developed for each of these fields for a total of thirty-one in all (see Table 1). Then these indicators gave rise to a scoring system to compare the baseline situation with the situation that the new system might generate. For the first two fields this score was based on quantitative references from agricultural research. For the other three fields the assessments took a more qualitative turn and were based on discussions with the farmers. This work resulted in figures that revealed the benefits to be gleaned from the new organization in each of the five fields (see Moraine et al. 2017).

Two hapless attempts to implement the experiment

At the end of this work, the farmers thus agreed on a roadmap for setting up the new agri-food network. This roadmap spelled out the changes to make in both production planning and the cropping and animal husbandry systems on the farms. It also established a preferential way to coordinate the exchanges that was suited to small territorial groups. Finally, it assigned the role of running the exchanges for the coming year to GAB Bio 82's technical adviser.

However, not everything transpired as expected. The changes planned for 2015 were not made. So, the farmers and researchers found that many organizational issues had not been well-enough prepared for. In some groups of farmers, responsibility for haying the alfalfa and composting the manure had not been clearly established. Transport was another, particularly ticklish, point: Some of the farmers felt that the transportation costs linked to the experiment were too high; others simply were unable to find transportation, since certain hauliers refused to take manure, even after it was composted.

In the face of this failure, the decision was made in 2016 to concentrate on a single group of two crop and four cattle farmers who were no more than 20 km from each other and volunteered to go on the experiment (Ryschawy et al. 2017). Two preliminary meetings were held to adjust the scenario. The farmers reached an agreement on the crop rotations needed to grow alfalfa and feed corn, which were both intended for sale to the cattle farmers. Price adjustments were also made to allow for the farmers' unequal involvement in the storage and delivery tasks. One last meeting was held before sowing the winter crops to allow for the year's weather conditions. These compromises seemed acceptable during the discussions, but, ultimately, not all the farmers stuck to their commitments. One grain farmer failed to deliver grain to a livestock farmer in the project, which created tension between the farmers. In addition, GAB Bio 82 lacked financing during this period and its technical adviser ultimately was not able to participate fully in the project. She was unable to guarantee that each participant met his commitments and to get after those who were remiss.

Analyzing the conditions and difficulties of “agencing” alternative agri-food networks

How can we explain these difficulties, if not these failures? A first response, which can be found in the agronomy literature (Meynard et al. 2013; Martin et al. 2016; Asai et al. 2018), is inspired by research on sociotechnical transition (Geels 2004). It consists in underscoring the constraints that come from the institutional rapports in the dominant sociotechnical regime. One then talks about a “lock-in” to underscore the fact that institutional rapports built in the past hobble the development of innovative types of organization, even if the latter seem to be more satisfactory. Agricultural research on crop-livestock integration has thus shown repeatedly that the knowledge, networks, and equipment that farmers have due to their inclusion in conventional agri-food networks make it difficult to establish complementarity between cropping and livestock farming. Next, depending on the case, other types of lock-in have been identified. These include criteria of professional excellence that do not value this complementarity, agricultural policies conducive to specialization in specific crops, and very demanding health regulations (Meynard et al. 2013; Martin et al. 2016; Asai et al. 2018).

Explaining these difficulties by the lock-ins that come from the dominant sociotechnical regime obviously is not unfounded. Yet, the sociology of market agencements enables one to analyze things somewhat differently. Rather than envisioning the weight of external constraints on the innovation process, it enables one to develop an analysis that focuses on the innovation process itself. Rather than explaining the difficulties of innovation by the lock-ins produced by the existing system, it shows that creating something new is difficult in itself. We

shall take this perspective in reconstructing the marketization processes that were carried out one by one.

Introducing new concerns

The sociology of market agencements beckons the researcher to analyze the experiment conducted as being motivated by criticism of the framings that stabilize conventional agri-food networks and the inclusion of new concerns (Geiger et al. 2014). In the case under study, this work was largely accomplished in the first participatory workshop involving the twenty-four volunteer farmers and the researchers. In this first step the farmers came to an agreement on what, in their view, was problematic and the aims of the experiment. Stressing this is important. Launching a process to change market mediations does not consist in finding solutions to pre-existing problems. The creation of alternative agri-food networks benefits from being understood to be an operation in which problems as well as solutions are identified. This teaching, which was already present in Callon's first writings on the sociology of innovation (Callon 1986), can be reiterated in experiments aimed at constructing new market agencements (Callon 2009).

The participatory workshops and, more generally, the participatory design method that we chose bring to mind what Callon calls a "hybrid forum" (Callon et al. 2002). Callon uses this term to describe situations in which the actors discuss market agencements explicitly. Their hybridness refers first of all to the fact that the concerns included in the discussions can be economic, environmental, moral, ethical, etc., with all these dimensions often being intertwined. It also concerns the participants in these forums. Hybrid forums are deliberative arenas hosting a heterogeneous set of actors: farmers, consumers, government bodies, scientists, and so on, but also the natural entities, such as the soil, climate, and ecosystems, for which these actors are the spokespeople.

The range of actors in the participatory workshops of our experiment was not that broad. The grain and livestock farmers close to GAB Bio 82 were the only ones to be invited and take part in the discussion with the researchers. In particular, there were no plans to have agricultural cooperatives, the firms that supplied agricultural inputs, and hauliers – all entities that might have proposed other organizational solutions – to take part. Still, one must keep in mind that the farmers and researchers did not come to these workshops alone and their sociotechnical networks affected the choice of concerns on which they settled. The researchers brought information that came out of their sociotechnical network, *i.e.*, scientific publications that highlighted the benefits of crop-livestock integration. The farmers, for their

part, regvanized some concerns that were highly valued in the national network to which GAB Bio 82 belongs, that is, the French National Federation of Organic Agriculture (FNAB). The will to create an alternative network conducive to crop diversification, territorial embeddedness, and the farms' self-sufficiency corresponded to the introduction of concerns that were closely tied to this affiliation. Let's stress the farms' self-sufficiency. It was important for both groups of farmers to increase their independence from both input suppliers and the cooperatives that distributed their produce via this experiment. They reproached these suppliers and distributors for forcing commodity chains over which they had no influence on them, especially when it came to the prices practiced. We thus understand better why these actors were not invited to take part in the "hybrid forum."

A hybrid "qualculation" between alternative and conventional

Hybrid forums do not aim solely to establish a dialog about the actors' concerns. The idea is indeed to include these concerns in the market framings. This perspective leads one to consider that operations making it possible to renew the areas of qualculation are core operations for creating alternative agri-food networks. Being attentive to these processes enables one to take a relatively clear-eyed view of things. This in turn makes it possible to establish the points on which the new agencement generates alternativeness but also the points on which it maintains existing assessment modes. So, in focusing attention on the modalities of qualculation, the sociology of market agencements gives an original boost to the traditional issue of alternative-conventional hybridization (Hinrichs 2003; Ilbery and Maye 2005; Kneafsey et al. 2008). In alternative agri-food networks, qualculation is hybrid: it combines innovative-alternative references and existing-conventional references. This hybridization is clearly visible in Steps 2 and 4 of the participatory design work concerning the scenario and ex-ante evaluation of performance, respectively.

The scenario drawn up in Step 2 thus strove to include new concerns, such as the farms' territorial embeddedness or autonomy (preferring feed based on local alfalfa rather than South American soybeans). However, it also strove to maintain some existing performance levels. So, the scenario defined the production and exchange levels that would maintain both the nutritional quality of the livestock's diet and the fertility of the grain farmers' land. For the first point, the initial and projected inputs were evaluated in energy and protein equivalents according to references produced by the French National Institute of Agricultural Research. For the second point, the calculations concerned the nitrogen inputs taking the inputs provided

by the introduction of alfalfa and legumes and the inputs from the composted manure into account.

The indicators used in Step 4 confirm this (see Table 1). On the one hand, indicators of dependence on outside inputs and marketing structures were added to reflect the new concerns. For the production of ecosystem services they concerned the degree of crop diversification, lengths of crop rotations, etc. Similarly, indicators of dependence on outside inputs and marketing structures were created to assess the concern for autonomy or self-sufficiency. However, on the other hand, some classic indicators of conventional agri-food networks were maintained. This was the case for soil nitrogen fertilization levels, the profit margins per hectare (in the case of vegetable crops), and feed costs (in the case of livestock). What is more, to evaluate the more quantitative indicators, the researchers relied on mean sectoral references. As Donald MacKenzie also pointed out in his study of carbon emissions market creation, agencing a new market can be done without re-opening all the “black boxes,” *i.e.*, contesting all the conventions required to construct the computation and equivalences (MacKenzie 2009). Some are modified or added, with the aim of generating alternativeness, while others are maintained.

TABLE 1 ABOUT HERE

Tricky nature pacification operations

The farmers' choice to exchange alfalfa hay for composted manure is also highly significant. It attests to the core nature of the goods quality adjustments to be made. An alternative agri-food network is not created around goods whose qualities, *i.e.*, characteristics, are known beforehand; on the contrary, the process entails coming gradually to an agreement on the qualities (Callon et al. 2002). The decisions to dry the alfalfa and compost the manure both affect the conditions under which the goods are produced with the aim of making them easier to store and to transport, but also to make them suitable for the user farms. Several stakes ride on this: guaranteeing nutritional inputs for the livestock and nutrient inputs for the soil, but also preventing the manure from disseminating weeds to the grain fields.

The fact that manure and alfalfa are living things or come from living things explains part of the difficulties encountered. Manure and alfalfa must be “domesticated” (Callon, 1986) so that they do not act contrary to the aims of the agencement. They must be “pacified” to become merchandise. The weeds that manure can introduce when it is spread on fields come from the seeds present in the cattle’s excrement. These seeds, which were initially in the grass or hay in their rations, are not destroyed by digestion. They are destroyed by the composting

step, where the temperature usually reaches 60°C. Alfalfa can be sun-dried out in the field after it is cut or dried in a barn with the possible addition of a heat source. Drying is necessary to prevent fermentation and rotting once the alfalfa is stored. However, this in-field drying has the disadvantage of losing the leaves, which contain the bulk of the plant's nutrient value. Producing good quality alfalfa hay is thus no mean feat: You have to know how to measure out the drying or have a barn with drying facilities.

The difficult recreation of market encounters and price setting

Paying attention to the processes making it possible to match supply and demand and set prices is also useful for analyzing alternative agri-food network creation. These processes are far from ancillary. The problems of identifying the available supply, storage, transportation, and price setting must be solved for the trade to take place. Having farmers willing to sell and consumers willing to buy is not enough for an alternative agri-food network to take shape. All the market mediation conditions must be met, too. When a market exists and operates stably, these elements may appear to be minor at first glance. However, as our experiment shows, when a new market agencement is being established, they are quickly seen to be core elements.

To show this, we can start by going back to Step 3 in designing the experiment. Once the production and trade scenario was established, the doctoral student and GAB Bio 82's technical adviser conducted a workshop to arbitrate among three models for organizing the exchanges: (i) a multirelational model along the lines of "classifieds," with a website for posting offers and requests and bilateral exchanges between livestock and grain farmers; (ii) a completely centralized model including investment in shared packaging, warehousing, and transportation facilities and equipment; and (iii) a polycentric model involving small groups of farmers who were geographically close to each other that would decide on and refine the ways they were organized locally (*Cf.* figure 1).

FIGURE 1 ABOUT HERE

To help them choose, each farmer was asked to write down the five strengths and five weaknesses of these three scenarios on post-its. The compilation of these strengths and weaknesses and following debate resulted in the group's opting for the third formula, which was deemed to be a good compromise between the long-term continuation of the exchanges and development of relations of trust (difficult to create in the "classifieds" model), on the one hand, and ease of implementation (as the centralized model required excessively high investments and commitment) on the other hand.

Nevertheless, many questions remained hanging at the end of this workshop. In theory, each group was supposed to find practical solutions for the transport, storage, and pricing issues, but also for composting the manure and drying the alfalfa. In actual fact, the failure to clarify all of these points led to these exchanges' not taking place during the first attempt to implement the scheme. Transportation was a crucial factor here. Some of the farmers envisioned doing the job themselves, but they failed to reach agreement with their colleagues on the amount of financial compensation that they would get in exchange. Others found that the professional hauliers refused to transport manure, even when it was composted, simply because it was dirty merchandise requiring the trucks to be cleaned afterwards. This last example shows that the scope of actors whose behaviors must adjust in a new market agencement can be quite broad. In the case at hand, the farmers were unable to "enroll" the hauliers (Callon 1986), thereby rendering the otherwise so conscientiously developed scenario null and void.

Stressing the importance of these marketization processes forces one more generally to take the intermediaries' roles in both alternative and conventional agri-food networks seriously. The movements that promote alternative networks regularly accuse intermediaries of being useless parasites that enrich themselves at the farmers' expense. There is no denying that the intermediaries in many cases do capture a large share of the value chain. On the other hand, the sociology of market agencements reveals that these intermediaries often have central roles in creating market relations. Through their work, they make complex adjustments between production and consumption, for example to allow for seasonality. They are also very often the ones that define and guarantee the quality of produce in order to make it "calculable" for the other operators. The ease of using the long market chains that is the daily practice of the majority of farmers and consumers in the industrialized world is the result of the mediation by middlemen. So, one should not be astonished to see that it is sometimes harder to sell or buy in short supply chains than in long ones. The former, like those studied in this article, often must be forged, whereas the latter are already established, broken in, and stabilized.

No new agencements without new attachments

Starting with the list of marketization processes, we can finally focus on the dynamics of detachment and attachment. The creation of an alternative food network assumes that detachments and attachments take place: Some actors must detach themselves from certain entities of conventional networks and attach themselves to new entities. According to Callon (2017), participatory design processes such as the one that was used in our case are

particularly effective for generating such movement. By permitting each party to express their expectations and constraints, they foster the learning and adjustments that ultimately allow detachments to take place and new attachments to stabilize. Yet in the case that we studied, that clearly was not enough.

On paper the farmers agreed to take the leap. What is more, during the second attempt to implement the experiment (with only six farmers), a host of organizational details had, in principle, been well defined. Yet, the experiment failed when it came time to put things in practice. The failure of one of the grain farmers to deliver grain to one of the livestock farmers in the project sufficed to capsize this second attempt. At the time, this farmer had spoken of “forgetting” and we unfortunately know nothing more about his motivations. Such an observation nevertheless enables us to assert, in an echo of the conclusions drawn in several recent publications, that “agencing and controlling markets are far from being synonymous” (Cochoy et al. 2016, p. 11; Geiger and Gross 2018). Building alternative agri-food markets comes up against the autonomy of the players, who may ultimately refuse the new attachments that they are supposed to adopt (see also Hébert 2014).

The existing attachments that form conventional agri-food networks are robust. They offer many advantages, even if they are not completely satisfying. In our case study, turning toward their cooperatives to market their harvests or to their input or feed suppliers to enrich their soil or feed their stock were simple routines that gave the farmers guarantees as to what would happen. The professional suppliers of inputs also gave the farmers advice about their cropping or animal husbandry practices, something that a neighboring stock or grain farmer would not be able to do. In a nutshell, detaching the farmers from their supply or sales chains is never a simple matter (Le Velly and Goulet 2015).

To come back to our case study, the attachment process's failure was equivalent to the failure to create a new agencement. Ending the analysis by bringing up the matter of agencement again is not trivial. Saying that the ability to act is distributed is tantamount to saying that the inability to act may come from any piece missing from a complex puzzle, a puzzle that is so complex that the pieces adopt their shapes as the puzzle is put together. If the outputs of one or the other party are not modified as planned; if, at the end of the day, quality, storage, or transportation is not guaranteed; or if the purchases and sales do not come about, then the alternative agri-food network does not see the light of day. Reasoning this way prevents one from overestimating the importance of one or the other factor in the creation process. Attitudes and motivations are vital for alternative agri-food networks to function; studies of the subject refer abundantly to this (Lockie and Halpin 2005; Best 2008; Raynolds 2009). Yet,

for all that, the sociology of market agencements reminds us that all the technical and material characteristics of the network, *e.g.*, the logistic schemes that are set up, quality adjustments, price-setting rules, etc., are essential for the successful creation of an alternative agri-food network.

Discussion and conclusions

The sociology of market agencements is a theoretical framework that is particularly well suited for analyzing the creation of alternative agri-food networks. Its principal message can be summed up as follows: Agencing new agri-food networks is a complex process that combines the completion of a series of operations that have already been done in the existing agri-food networks. To create an alternative agri-food network, which must function in ways that are aligned with the network's new purposes, there is a need to (i) agree on new definitions of quality, (ii) redefine the ways that goods and services are assessed, (iii) restore functional trading circuits, (iv) agree on prices, and v) detach the actors from their customary networks. All of these operations are probably not always present in the agencing of new agri-food networks, but it is worthwhile to keep them in mind in order to be aware of the magnitude of the work required. We thus understand why there is nothing simple about creating alternative agri-food networks and why conventional agri-food networks are particularly resistant, even when their critics show the many problems that they generate. The sociology of market agencements tells us that creating alternative agri-food networks is a dicey operation that calls for settling a considerable number of issues. It therefore is not surprising that their creation, one that culminates in a new, stabilized sociotechnical arrangement, is seldom successful.

To conclude, we can finally come back to the multilevel perspective. This discussion is a must, given that this analytical frame is tending to become an unavoidable reference for analyzing transition processes in agriculture and food (for a review of the literature, see López-García et al. 2019). What is more, Callon and Latour's sociology of innovation is one of the sources of inspiration of the multilevel perspective, notably through its assertion of the co-determination of the various components of sociotechnical networks (Geels 2004).

In comparison, does the sociology of market agencements contribute anything different? In our opinion, it makes a contribution in the form of a different theoretical conception of the process of innovation and sociotechnical lock-ins. The researchers inspired by the multilevel perspective thus differentiate niches, in which the alternative agri-food networks take shape, from sociotechnical regimes, which are vectors of lock-ins that maintain conventional agri-

food networks, and landscapes, where exogenous modifications that can reinforce or weaken the niches and regimes arise. The sociology of market agencements recognizes the existence of lock-ins fully (Callon 1998, 2017). Yet for all that, like ANT, it requires an analysis in which “nothing is left outside” (Çalışkan and Callon 2010, p. 9): In other words, the explanation must not be sought outside the agencements. As Geels points out quite clearly, it rests upon a “flat ontology” as opposed to the “hierarchical” analysis used for the different levels of niche, regime, and landscape (Geels 2011). For the sociology of market agencements, the alternative is not on the side of niches and the conventional is not on the side of the regime.

Just as ANT makes it possible to think non-dualistically, in a way that mixes the local and global (Murdoch 1998), nature and society (Goodman 1999), or production and consumption (Lockie and Kitto 2000), the sociology of market agencements makes it possible to understand that conventional agri-food networks are present in all the steps of an alternative agri-food network's creation. Whether they are contested and replaced when it comes to certain points or kept in part, with some of their entities serving as foundations in the alternative network, conventional networks are part of alternative networks. The alternative networks may even remain in thrall to their efficiency and not be able to detach itself from them. Finally, the sociology of market agencements combines the niche and regime, innovation and stability, and the alternative and conventional in one and the same process.

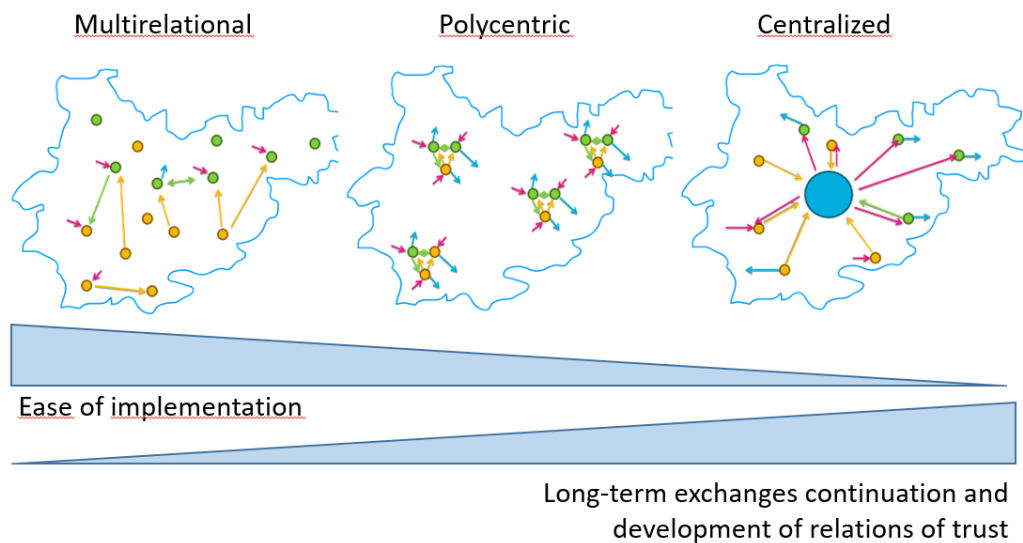
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Table 1. Concerns, criteria, and indicators used for the ex-ante assessment of the territorial trade scheme between livestock and crop farmers.

Asterisks denote indicators that were estimated by producers qualitatively. Other indicators are quantitative indicators estimated at the individual level and averaged for the group. Adapted from Moraine et al. 2017.

Concerns	Criterion	Indicator
Metabolic efficiency of the system	Crop systems	Amount of exogenous N-source fertilizers (t N/year)
	Livestock systems	Amount of exogenous fodder (t/year)
		Amount of exogenous concentrates (t/year)
		Amount of exogenous straw (t/year)
Production of ecosystem services	Organic manure application	Area of arable land receiving organic manure (ha)
	Symbiotic fixation of N	Percentage of legume crops in the crop rotation (%)
	Diversity of crops at field level	Duration of crop rotations (years)
		Number of botanical families
Diversity of land use at landscape level	Abundance of grasslands in landscape*	
Socioeconomic performances	Workload	Amount of work *
	Work quality	Difficulty of work *
	Stability of costs	Stability of supply and prices *
	Added value of products	Development of quality labels *
		Direct sales and collective shops *
		Use of by-products *
Profitability	Gross margins in crop rotations (€/ha) Costs of animal feeding systems (€)	
Social learning and capacity building	Autonomy of farmers	Independence from commercial organizations*
		Institutionalization of groups*
		Structure of exchanges*
Knowledge capitalization	Exchange of practices and results of trials*	
Adaptive capacity	Strategic planning and tactical adaptation to annual conditions*	
Social and territorial embeddedness	Social acceptability of agriculture	Landscape quality*
		Direct producer-consumer relationships*
		Animal welfare *
	Contribution to local economic dynamism	Quality of products*
		Tourism activities *
Contribution to local and global sustainability issues	Development of local supply chains and new activities*	
	Establishment of new organic farmers*	
	Conversion to organic farming*	
	Impact of farming on water quality*	

Figure 1. Schematic representation of the three considered models for organizing market encounters



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