# How the living shapes markets: accounting for the action of biological entities in market agencing

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## Abstract

Market sociology research has accounted amply for the importance of material devices in shaping markets. In contrast, the influence of biological entities (such as parasites, soil, and food) on market agencing has barely been considered. This article shows the relevance of covering this matter specifically. To do so, the authors refer to their analyses of the production and sales practices of organic vegetable market actors in France. Based on descriptions of four situations, they show that the biological processes involved in the cultivated ecosystems and agricultural produce itself influence the market agencing processes that these actors carry out. Based on these first observations, they propose four generic statements that clarify what considering the action of biological entities involves in terms of theory and identify avenues for future research.



## Keywords

Agriculture, Actor-Network Theory, Food, Living, Marketization


## Introduction

Since Michel Callon's trail-blazing article (Callon 1998), a wealth of Actor-Network Theory (ANT)-inspired research into market sociology has accounted for the importance of material devices in shaping markets. We can mention the actions of shopping carts, sales areas, and packaging in the emergence of self-service retailing in the mid-20th century (Kjellberg and Helgesson 2007, Cochoy 2015); those of computational infrastructure in the various configurations that financial markets can take (Callon and Muniesa 2005, MacKenzie 2009, MacKenzie 2021); and those of quality standards and logistics in the formation of international agricultural commodity markets (Busch 2011, Ouma 2015). These and many other investigations have shown the extent to which the world of buying and selling is a "material world" (Pinch and Swedberg 2008) and how seemingly mundane objects can influence the course of events decisively (Neyland et al. 2018, Delvenne 2020). From a more theoretical point of view, they have also shown that human beings' agency in markets must be understood as distributed agency: the material devices enable and channel actions; "they act or they make others act" (Muniesa et al. 2007, p. 2).

Compared with these advances, another lesson of ANT was paid much less attention in market research: amongst the "non-human" actors that ANT reintroduces in the analysis (Callon 1986, Murdoch 1997, Latour 2005, Sayes 2013), the action of biological entities was analysed much less in market studies. Under the term "biological entities" we group a diverse range of entities, since we are targeting small entities, such as parasites and seeds, as well as vaster entities, such as soils and ecosystems, with plants and animals in between. If we refer to the definition of "biological" in the Cambridge Dictionary, all these entities share the fact that they are "connected with the natural processes of living things". The fact that they are living induces the phenomena of reproduction, growth, and senescence that make them less easy to control than non-living entities. To state it differently, biological entities are marked by spontaneous physical-chemical transformations, whether short- or long-term changes, that generate variety, uncertainty, and perishability. We thus hypothesise that these properties weigh upon market shaping processes in ways that need to be analysed.

To test this analysis, we shall focus in this article on a sector that has particularly close connections with the living and biological entities, namely, agriculture. Indeed, this article draws upon the results of research into French organic farming that was conducted initially with the purpose of studying how these collectives of organic farmers tried to "agence markets" (Onyas and Ryan 2015, Cochoy et al. 2016) in line with their political aspirations. However, in observing them, we found that these farmers never thought of agencing markets independently from the biological processes with which farming and foodstuffs – and in organic farming even more so – confronted them, i.e., the emergence of weeds, need for soil nitrogen, seasonality of crops, perishability of merchandise, etc. In short, their practices made us realise how important it is for those who are agencing markets not to neglect the actions of biological entities.

To recognise this action of biological entities in shaping markets, but also to clarify from a more theoretical standpoint how it should be understood, we have organized this article into four sections. We shall start by recalling how ANT includes biological entities in its analysis on the one hand and taking stock of the all-too-rare market sociology studies that have pursued this objective on the other hand. In the second section, we shall present the current period of changes and worries experienced by the organic farmers whom we surveyed, and spell out our survey method. We shall then, in the third part, expound upon four series of observations that illustrate in different ways the importance of biological processes in market agencing. Finally, the fourth part will strive to take stock of these observations. Through a

series of general propositions, we shall specify what considering the action of biological entities in market agencing involves and identify a series of avenues for future research.

## Theoretical background

Biological entities hold an important, even founding, place in ANT. In following the principle of human/non-human symmetry, Callon's founding article thus strove to show the importance of the action of threatened scallops, with their movements over the sea floor and researchers' attempts to attach them to the devices that would ensure their survival (Callon 1986). These natural entities belong, just like material devices, to the category of "actants" that ANT reintroduced into sociological analysis. Let us remember that in using this term "actant", Bruno Latour does not give humans and non-humans identical status. What is at stake is to be attentive to the way that the latter "make a difference in the course of some other agent's action" (Latour 2005, p. 71). In Jane Bennet's words, the "actant is a source of action that can be either human or nonhuman; it is that which has efficacy, can do things, has sufficient coherence to make a difference, produce effects, alter the course of events" (Bennett 2010, p. viii). Seen from this perspective, agency, that is to say, the ability to act, is never exclusively that of human beings. It is always distributed within "hybrid collectives" (Callon and Law 1995) that combine human, material, and biological entities. For example, Pasteur's discovery of lactic acid bacteria was not just the result of the scientist's action; it was also the fruit of the actions of his laboratory instruments and of the bacteria themselves (Latour 1999).

There has recently been a resurgence of special interest in taking account of biological entities' abilities to limit or orient the development of socio-technical networks in science and technology studies focusing on the ecological transition and bioeconomy. Considering the "withdrawal" of certain problematic technologies in agriculture, such as pesticides and farming equipment, Goulet and Vinck (2017) have shown the importance of considering the action of certain living entities – soil fauna, beneficial insects, and beneficial microorganisms – to ensure the proper operation of agricultural systems. Rather than being seen as obstacles to production, biological entities have become production tools in their own right, actants at work (Barua 2017) whose existence and action are promoted: life is used to "manage life" (Lorimer 2020). However, the living is obviously not always seen in a positive light: if we switch to another register, the importance of technologies developed to control, even to suspend, the properties of living things, especially their mortal or perishable nature, has confirmed their importance and specificity (Radin 2013, Lemke 2021).

In comparison, just a few studies have started to explore the influence of biological entities on the organization and working of markets. These studies, which have been published by scholars of rural sociology or economic geography, continue in the vein first mined by Callon (Callon et al. 2002) to try to explain the difficulties encountered in stabilising the quality of agricultural goods (Legun 2015, Le Velly and Dufeu 2016, Henry 2017, Wang 2018, Ouma 2015, Birch 2019, Bonnaud and Anzalone 2021). Yet their analyses continue to focus on setting up market devices (of preservation, standardization, calculation, commercialisation, etc.). They thus account for the influence of biological entities only in passing. What is more, they tend to consider this influence to be an outside constraint on market forces rather than to see biological entities (forests, animals, vegetables, insects, bacteria, etc.) as true actants with which humans interact. Recently, a special issue of *Organization Studies* put the ways that organizations are affected by the "bio-materiality" of food, i.e., the specific materiality of these living goods, at the heart of its analysis (Moser et al. 2021). Nevertheless, Arnold and Loconto's article on Ghanaian pineapple supply chains (Arnold and Loconto 2021) was the only one in this issue to tackle the market, and from a perspective identical to that used in the publications we have just cited, we might add. Wang's latest article (Wang 2022) goes one step further. In research centred on biosecurity policies in the Taiwanese pork market, he clearly shows that the agency and vitality of viruses and microbes make it impossible to completely avoid health risks in the global pork market. However, as far as we know, there is not yet any research focusing systematically on the action of biological entities on markets.

Tim Ingold proposes in this regard a diagnosis that is relatively comparable to ours. His criticism is levelled at material culture studies and does not target ANT-inspired market studies directly. That being said, in our view what he says about the former nevertheless seems to be valid for the latter: "material culture studies continue to operate with a conception of the material world, and of the nonhuman, that focuses on the artifactual domain at the expense of living organisms" (Ingold 2012, p. 428). Ingold then urges us to look at things differently, to go from analysing our relations with things as "already made" to analysing the processes that mix the living entities that are constantly creating and breaking down these things. If we translate this to our field of study, organic farming, it means taking the biological processes involved "from farm to fork" into consideration, i.e., those taking place in the fields, agri-food factories, sales networks, and the merchandise itself, at each stage in its life. It also means giving weight to the sensible knowledge of the actors who observe or interact with these entities at these different stages: their experience with living things (during their

growth or as a merchandise) can be considered in Ingold's approach (Ingold, 2000) as the main entrance to grasp why and how biological entities act and interact with their environment. Let us point out that Ingold (2012) also faults ANT for being insufficiently able to allow for the flows of energy and materials specific to the living world (for a development of this criticism, see Ingold 2011, Chapter 7). However, based on the arguments presented at the start of this section, we consider ANT to be an enlightening reference to grasp the actions of biological entities. In our opinion, Ingold's questions are useful as a reminder not to lose sight of biological processes, but they do not require breaking with the analytical framework of ANT.

To sum up, we think that ANT-inspired market studies have not taken account of the actions of biological entities as much as they should, including in order to observe the principles of ANT. If we consider "market agencements" (Callon 2021) to be hybrid collectives made of human, material, and biological entities, we can hypothesise that their agency is distributed over these three components, not just over the first two.

**Materials and methods**

As stated in the introduction, the survey that we conducted was not initially intended specifically to study the actions of biological entities in market formation. It was motivated by questions about "market innovations" (Kjellberg et al. 2015) developed in response to new "matters of concern" (Geiger et al. 2014). Specifically, organic farming in France entered a phase of strong growth and transformations at the start of the last decade. In just thirteen years (2007-2020), purchases of certified "organic" products increased sixfold, going from 2 to 12.8 billion euros, whilst the number of certified organic farmers quadrupled. Not just the number, but also the type of actors in this market changed. More and more farmers, processors, and distributors who until then had been far removed from the organic sector entered the French organic agriculture market. The actors with a longer history in the sector were afraid that these newcomers would not be sufficiently apprised of the historical values of organic farming, such as the search for a living wage ("remunerative prices") and fair trade relations. This was the specific case of certain farmers who tried to act on how their trade relations with their customers (traders, processors, and/or distributors) were organized. Our survey focused on these actors in order to reconstruct their market agencing practices.

We conducted surveys in the "field crop" areas of northern and central France (Hauts-de-France and Centre-Val-de-Loire Regions) between 2016 and 2019. We did thirty-two semi-

directed interviews: eighteen with organic farmers specialised in vegetable crops, nine with employees of two economic operators to which they sold their vegetables (the cooperative *Norabio* and the trader *Ferme de la Motte*), and five with task officers from development bodies created to support organic farmers (*Bio Hauts-de-France* and *Fédération nationale de l'agriculture biologique*). We completed the picture with a dozen days of observation of the work done on the farms and in the two economic operators' offices and warehouses. Finally, strategy and sales-oriented documents (production contracts, planning and price calculation spreadsheets, and the minutes of strategy meetings) were collected to enable us to specify the types of market device that were mobilised for the preparation and day-by-day management of selling the harvests. We then coded the collected data manually and inductively, with analysis of the economic risks linked to the market dynamics of the expanding organic agricultural subsectors on the one hand and the practices aimed at agencing the organic commodity chains on the other hand.

As this work advanced, a surprising result that we had not fully anticipated emerged, to wit: the market agencing done by the actors whom we studied constantly had to allow for the actions of the biological entities involved, in both the agricultural production and the processing and marketing phases. With hindsight, it now appears to us that this result was not so surprising. First, sticking closely to the analytical principles of ANT should have led us to try to observe these biological entities' actions more systematically. Second, organic farming is specific in that the use of chemical inputs such as synthetic pesticides and fertilisers and preservatives is forbidden. It defends respect for certain biological and ecosystem processes and is thus heavily dependent on their idiosyncrasies. As a result, we were especially likely to be confronted with the influence of biological entities.

**Four series of observations exemplifying the action of biological entities**

Four series of observations provide evidence of the prominent influence of biological entities on market shaping with particular acuity. In line with our inductive approach, we shall present them as they cropped up in the course of our surveys. We shall start with the practical market organization issues with which the organic farmers and middlemen have to grapple and see how biological entities act in this context. This part will describe the cases that we studied in detail. The next part will take a more analytical tack by crossing the four series of observations with each other.

***Working with hard-to-domesticate biological entities in order to escape price competition***

Our first series of observations concerned farmers well grounded in organic farming. They farm large acreages, with operations that are both mechanised and rely on a large number of employees. They have trade relations with both agri-food industries and traders who then work with the mass distribution sector. For this group of farmers, the changes that the sector is currently undergoing are a source of economic risk, i.e., lower prices. They fear that the rapid conversion of large farms to organic agriculture will generate an uncontrolled increase in the volumes produced and the new organic farmers will agree to cut their prices in order to sell more produce.

To cope with this risk, these experienced organic farmers are developing strategies that are just as product-oriented as they are market-oriented (see Vatin 2013). The first one consists in investing in equipment enabling them to sell their vegetables at a later stage in the marketing cycle. That means that they take on the tasks of storing, grading, and/or bagging – work that they did not do heretofore and in which their new competitors are not yet engaged. The second strategy is to grow vegetables requiring specific knowledge and sometimes investments. They know that such crops are risky, but they also know that the recently converted farmers do not master them. These farmers thus divide their crops into two families. First there are the more common crops, such as cereals, potatoes, and beets. These crops are easy to add to a farm, as a result of which the markets for them can be easily destabilized by the newcomers. That is why Benoît and his son, Émile, for example, decided to avoid planting potatoes:

> The potato is an annual crop that is already grown by many in the conventional farming sector. They can get access to equipment fairly easily. The crop is technically less difficult and, motivated by opportunism, they can grow this type of crop more easily from one year to the next. As a result, you could have a short- or medium-term market glut. (Émile, 30 years old, Nord Department, 2017)

Benoît and Émile chose to include some more technically-demanding species, such as the Belgian endive. This northern speciality requires special techniques and major investments, notably for storing and forcing the roots. Forcing the endives' roots is a technical procedure that takes place after field cultivation. Once maturity is reached, the endive is dug up to recover the largest roots. The roots are then placed in a controlled atmosphere and germinate to produce an edible endive. This operation is tricky. For example, higher temperatures will

speed the endives' growth but also carries the risk of their rotting faster. Finally, the rosettes of white leaves are cut off from the roots, bagged, and sold to supermarkets. Not a single endive can be sold if the root fails to undergo this special treatment.

The onion is another vegetable considered to require complex learning before it can be grown. It must be weeded with great precision, for onion bulbs create no shade, leaving the ground between the seeded rows exposed to full sunlight. Adventitious species thus grow in the bare earth between the onion rows: the seeds of weeds sprout, grow, and compete with the onions. Once again, there is less risk of newly converted farmers' opting for this type of crop, because it is known to be one of the hardest to weed. You have to know exactly which stages of growth the onions and weeds have reached in order to take action at the right time. Moreover, these operations require special equipment that the newcomers do not have: thermal weeders, precision instruments such as camera guidance for hoeing, coupled with GPS-guided precision sowing by tractor. You also have to have a large number of labourers, for onions must be weeded by hand at least once. One hectare of onions can require more than 200 man-hours of labour to remove all the weeds.

So, the ways that certain species grow require mastering certain technical practices, the mobilisation of workers and specific equipment, and special learning. This difficulty is precisely the argument that convinces certain farmers to prefer such species in order to ensure success on the market: working with recalcitrant varieties is for them a way to get out of more competitive markets. All in all, this case shows that biological entities are sources of constraints for farming and food markets, especially when it comes to organic farming. However, it also shows that certain actors on the market can rely on these entities' actions to develop their own production and sales strategies. The farmers who can work with such entities and cope with their actions form hybrid collectives that are able to act in the highest-paying market segments.

***Biological processes that force changes in the organization of production and sales***

The second series of observations concerned Bio Hauts-de-France, a body created by some organic farmers in the Hauts-de-France Region (northern France) to support their expansion. Bio Hauts-de-France's technical advisers have been convinced since 2010 that the difficulties of selling all of the crops in the crop rotation schemes required in organic farming is a major hobble on the growth of organic farming in their region. The market agencing problems and solutions alike are thus closely tied to biological processes.

Complying with the standards of organic agriculture requires dispensing with the use of synthetic pesticides and fertilisers; crop diversification is thus a must. Some inputs are authorised in organic farming, but to deal with the problems of fertilisation and plant health (and thus yields and quality), organic farmers rely mainly on crop rotation schemes. The length of a rotation cycle, which is counted in years, corresponds to the number of species that alternate one after the other before the same species is once again grown on the same plot. Lengthening the rotation cycle has an impact on weed, pest, and disease management. The main crop diseases appear due to telluric fungi, bacteria or viruses specific to each crop. The diseases develop when cultivation begins et produce germ reservoirs that persist in the soil. The pathogens will be ready to spread the next years if the same crop is sown but slowly die out if not. The same reasoning applies in similar fashion to pests and weeds: alternating crops disrupts these biological entities' life cycles by changing their habitats from one year to the next. The longer the rotation cycle, the lower the probability of weeds' re-emerging or disease appearing when it is time for the same crop to be planted on the same plot.

These long rotation cycles entail crop diversification on the farm *de facto*. For Bio Hauts-de-France's advisers, the issue is thus to allow for the constraints that biological processes place on marketing farm produce. Before opting for crop diversification, the farmer who wants to convert to organic agriculture must be certain to be able to sell the new crops in the cycle. To solve this problem, Bio Hauts-de-France held meetings between farmers and economic operators from different commodity chains – cereals, vegetables, and legumes – in the mid-2010s. These gatherings made it possible to get these operators to understand that their respective requests to increase the volumes of a given cereal, vegetable, or legume were at odds with the constraints of crop rotation. They made these operators aware of the economic challenges that the soil biological processes in organic farming involved. Bio Hauts-de-France then came up with an original type of contract. It took the form of an at-least-five-year contractual commitment enabling the farmers to ensure a rotation of at least five different species on each plot. Most important, it united a group of farmers and operators from different commodity chains. Unlike what is usually done, the farmers did not have to find contracts tailored to their cereals, vegetables, and legumes themselves: a single multi-produce, multi-channel contract was signed.

A second problem cropped up when the farmers included vegetables in their rotations. In this case, selling the harvests was of no concern, for the demand for organic vegetables is very high, especially from organic supermarkets, and the logistic services for delivering them exist.

The problem once again was linked to the properties of the cultivated ecosystems. Vegetables have high nitrogen demands and deplete soil fertility. To restore soil fertility, nitrogen is supplied either by buying fertilisers or by growing legumes. The latter option is complicated by the fact that legumes are introduced into the rotation in two main forms. The first one is to plant alfalfa, a high-protein plant that is used in animal feed. Alfalfa roots have a symbiotic relationship with bacteria enabling them to capture nitrogen from the air and bind it to the soil. However, this crop takes root slowly and must remain two, even three, years on the same plot. Working with alfalfa thus means having a seven- to eight-year rotation cycle, which creates further constraints for the farmer. The other option is to choose a legume such as the pea, which develops faster, and combine it with other crops on the same plot. For example, the triticale-pea mixture is deemed interesting by farmers and advisors alike. Triticale is a rustic hybrid wheat used in animal feed while the pea is a legume that winds around the triticale stem. It is thus a perfect association for production. A problem then arises after harvesting, for the two species are mixed and thus have to be sorted. There are special machines for this that separate the grain according to weight, size, or density. But these are expensive machines that one farmer alone usually cannot buy. The farmers thus must invest in such a machine together or wait for their buyers – for example, their cooperative – to acquire one.

So, organic agriculture, which does not rely on the "tricks" and technologies of synthetic inputs, is highly dependent on biological processes. If an organic farmer opts for mono-cropping, the soils lose their fertility, weeds and parasites spread, and the plants grow poorly. Crop diversification is thus an inevitable response to this situation. The successive crops that follow each other year after year disrupt the weeds and parasites' life cycles and some of them even restore soil fertility. However, including this production constraint in the markets' agencing is not easy. In the case of the multi-commodity contract, the economic operators must agree to coordinate with each other, so that each supplier is able to sell all the crops in his/her rotation. In the second case, the triticale-pea mixtures require solving a material constraint, that of separating the different types of grain, with expensive investments. So, this second case confirms the merits of thinking about how agency is distributed: the farmers' ability to act depends on other human entities (commodity chain operators), material entities (contracts, sorting machinery, etc.), and biological entities (soil, weeds, parasites, bacteria, plants, etc.) that combine to shape the ensuing markets.

***Coping with the uncertainty and variability of agricultural production***

We shall now tackle a classic question of agricultural markets, whether the products are organic or not, namely, the variability of yields. Most farms have to cope with unpredictability linked to the ups and downs of farming (weather, infestations by pests or disease, etc.). Even though varietal selection and other technologies minimise the effects of these vagaries, they never disappear completely. As organic farming does not use chemical inputs, it is even less well equipped than conventional farming to prevent or manage the variability and unpredictability of production. That affects the marketing conditions and the farmers' market agencing efforts.

Within the cooperative Norabio, the sales personnel negotiate sales conditions with industry to allow for the diversity of the grades harvested by the cooperative's members. To achieve such aims, they first seek to commit to several customers. In the case of beets, Norabio thus contracts with three industrial firms that do not use the same grades of beets. One of them takes small but not large-calibre beets, whereas another accepts large but not small-calibre beets. In another case, a member had carrots that were too small and ringed, which made it difficult to sell them as is on the fresh vegetable market. The cooperative was able to negotiate the sale of this batch of carrots to a frozen vegetable supplier. For potatoes, similarly, it is sometimes possible to shift volumes intended for the fresh to the processed vegetable market, and vice versa. Norabio's sales representatives sometimes enter into more complex negotiations with their customers. We learned of one case of a harvest of carrots that were too long, i.e., more than 22 centimetres, whereas the customer's specifications stipulated a length of between 18 and 22 cm. This size requirement stemmed from visual criteria of homogeneity, but was also linked, more simply, to the size of the bags that the customer used. In this specific case, the customer agreed to use longer bags!

Other arrangements making it possible to manage variability can be seen in Ferme de la Motte's trade practices with the farmers who supply the trader. These farmers explained that this trader strove to establish partner relationships with them that included creating safety nets to deal with production ups and downs. Two examples show this. The first one was reported by Julien, who began growing onions in 2014. At the start of our discussion he told us that his last two years had been catastrophic because his freshly sprouted bulbs had been infested with onion fly eggs. Given the lack of effective control measures against this pest in organic agriculture, his harvests were very poor. Instead of considering him to be solely responsible for the drops in yield, Ferme de la Motte paid him enough to cover his overhead and advised

him on preventive control measures. The second example concerns the years in which all of the farmers in the region post abnormally low yields. In this case, Ferme de la Motte also usually manages to sell the produce to its agri-food industry or mass distribution customers at relatively high prices. These downstream negotiations may have repercussions on the farmers upstream in the chain. Indeed, although nothing obliges it to do so, Ferme de la Motte sometimes increases its payouts to the farmers above the prices initially negotiated in its contracts.

The biological processes in cultivated ecosystems are not totally controllable, and even less so in organic farming. The interactions between their component biological entities result in good or poor yields, depending on the year. And despite varietal selection or strict compliance with technical guidelines and practices, agricultural produce does not always have the expected size, shape, or colour. Such qualitative and quantitative variability and unpredictability require tactical adjustments and new forms of market agencing.

***The bio-materiality of agricultural produce that affects their marketing***

Our fourth series of observations concerns what becomes of agricultural harvests, i.e., their storage, distribution in the fresh state, or agri-food processing. In this section we shall see how biological processes such as ripening or ageing that affect harvested produce (their appearance, texture, taste, smell, etc.) are taken on board either by techniques aimed at controlling them or by negotiating over quality criteria.

The case of the potato is a good first example. To sell them in supermarkets, should they be washed in water or simply brushed? This choice is not at all innocuous. When potatoes are washed, tiny flaws (which are more numerous in organic than in conventional farming due to the ban on certain chemical treatments) are immediately visible. Part of the harvest is then no longer accepted by distributors and remains in the farmers' warehouses. What is more, brushing off the dirt reduces the potato's storage life, which has implications for the distributors' supply chains. When France reaches the end of its storage capacities for washed potatoes, the distributors' only option is then to import them from Israel or Egypt, where the new potato harvests start earlier. The option of selling brushed potatoes corresponds to the usual practices of specialised organic shop networks. Only some of the soil is removed, even if that means hiding certain flaws and soiling the boots of consumers' cars or their kitchens. Today this second option is also being considered by the major mass distribution chains, which are betting that consumers will prefer these flaws and inconvenience to buying imported produce.

The bio-materiality of organic potatoes is also important for agri-food processing. To make crisps, the potatoes must not contain any traces of sugar. Once fried, a potato that contains sugar produces brown, even black, crisps, which are considered unsellable. This sugar build-up is directly linked to the low temperatures that are required to lengthen the potato's warehousing period. To keep potatoes after harvesting, they are stored in cold rooms at temperatures ranging from 6-7 °C for up to six months to 4 °C for 9 months' storage. Such temperatures prevent sprouting but also increase the transformation of starch into sugar in the tubers. At 4 °C any sugar build-up is irreversible. This problem does not arise for conventional potatoes, for which applications of chemical antigerminants are permitted, making it possible to store them at higher temperature. Only in 2010 was a new technical solution deemed compatible with the principles of organic farming approved, namely, hot misting with mint essential oils to prevent sprouting.

Our second example concerns peas. In 2016 two Bio Hauts-de-France advisers were contacted by a frozen food company that wanted to roll out a line of organic peas and draw up a supply contract that would be attractive for farmers in the region. The meeting thus focused as much on prices as on quality. The industrial concerns refer to a "tenderometry" index for peas that is an indicator enabling them to judge whether the peas are tender or mealy. The usual standard for a "good" pea stipulates that tenderness at harvesting must be 110 for frozen peas and 130 for tinned peas. This indicator varies 2-3 points in the field as the peas are maturing and then 10-15 points once the pea is well formed and ready to harvest. The window of opportunity for getting a good harvest is paper-thin, even for a plot on which each pea plant has grown at exactly the same pace as its neighbour: a few days' delay and the peas become too hard. Achieving this goal of tenderness has nothing to do with processing issues, unlike the case of potato crisps. The industrial machines that are used to cook peas couldn't care less about their degree of tenderness; here, tenderness at harvesting is guided by an organoleptic standard that reflects the consumers' estimated taste preferences.

For the contracts to appear attractive to organic farmers, two different solutions were envisioned during the discussion between the frozen food company and two Bio Hauts-de-France advisers. For the first adviser, the farmers had to meet the company's requirements: if the company wanted tenderometry 110 peas, it would have them; the challenge was technical. Jean-Philippe also defended a high price (€750/tonne), since reaching this quality required more and more complex work in the fields. The second adviser, Alexandre, tried on the contrary to get the frozen food company to understand that if it wanted their organic peas, it

would have to change its terms of reference to increase the quantities of organic peas paid for after harvesting. He even proposed the price of €550/tonne to allow for that. If the acceptance criteria were more flexible, the company would be able to take up a larger proportion of the total harvest. For Alexandre, negotiating over quality was fundamental to preserve the sustainability of the organic farms. He targeted the risk of massive rejection of the peas produced due to quality deviations. In conventional farming, agri-food companies frequently refuse produce even though the insufficient tenderness is due to harvesting delays attributable to the company's poor organization. Alexandre's position was thus just the opposite of Jean-Philippe's: it was not up to the organic farmers to meet their customer's demands by innovating and improving their performance but rather the operators and distributors' demands had to change to allow for the problem of organic peas' variable tenderness.

The bio-materiality of agricultural produce such as potatoes and peas is a vector of constraints on turning the produce into merchandise. This is even more true for the products of organic agriculture, which gives more freedom of expression to the actions of their biological components. Putting these products on the market thus entails more innovative "agencements" than the arrangements that exist in conventional markets. In the first case, since the natural development of sugar in organic potatoes made them unsuitable for industrial crisp preparation, a technological innovation was found. In the second case, given the great variability of green peas in organic farming, the parties discussed changes in the rules setting the price and qualities of the produce.

## 3. Discussion

"How the living shapes markets". Analysing the previous situations by the yardsticks of ANT and the action of biological entities enables us to put forward four propositions for discussion, for testing on other markets, and to inspire future research.

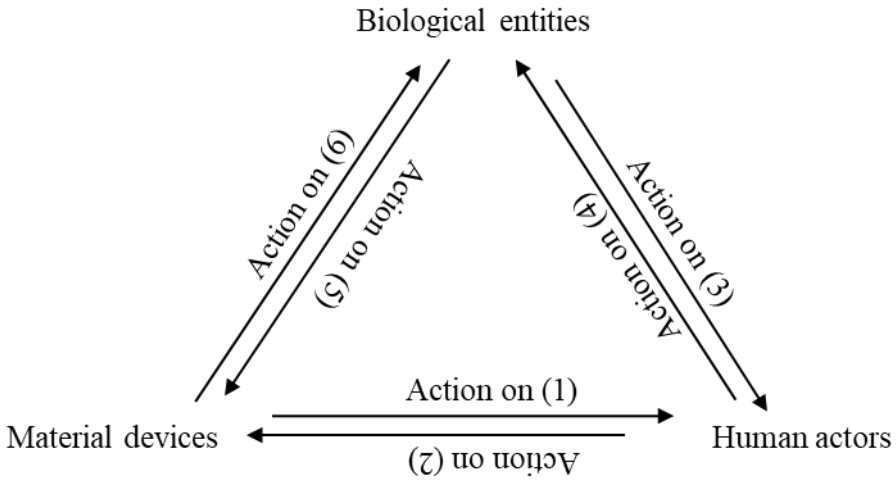
First of all, these situations show how much market agencing processes reflect co-determination by the social, material, and biological. For that reason, these three categories are, moreover, slightly embarrassing. We can see that the processes at work in cultivated ecosystems or post-harvest are far from independent from the social and material. They are indeed affected by the implementation of organic farming standards, cropping decisions on the farms, prior variety selection, storage and preservation choices, and so on. In the situations that we studied, regulations forbid the professionals' using synthetic substances or artifices that would abruptly shut down the expression of some biological processes. Organic

production thus relies on the spatial and temporal complementarities of the components of the cultivated ecosystems through crop rotations, crop associations, the care given to soil micro-organisms, and so on. Here we find a classic lesson of ANT (see Murdoch 1997), namely, that recognising the action of biological entities in no way means that some natural determinism is at work according to a dualistic reasoning that conceives of nature's action on society. The issue is rather to understand how hybrid collectives form, to see markets as "agencements" in which human, material, and biological entities take shape jointly (Callon 2021). In other words, the aim must not be to make biological processes the factors that explain the observed phenomena, but to describe the processes that stabilise the agricultural ecosystems, merchandise, and other market components in a certain state. Our first proposition is ultimately as follows: *Market agencing processes are processes that co-determine biological, material, and human entities.*

This first proposition calls for research that specifically accounts for the influence of biological entities. The bio-materiality of merchandise and, more generally, the action of biological entities have been paid scant attention in market sociology, including in the work inspired by ANT. Yet our research with the actors of organic farming shows that this is a relevant perspective, confirming the hypothesis that we stated in the introduction. The bio-materiality of agricultural production and challenges linked to plant growth in the field impact the ways the instances of economic coordination are organized. In the first situations described in this paper we stressed the biological processes that took place in the agricultural production phase: persistence or disappearance of soil-borne diseases, nitrogen imports and exports, effects of alternating crops, and the disruption of plant growth by the spread of weeds. As we have seen, these processes influence the farmers' production and marketing practices. For the subsequent situations, the influences of the biological entities were expressed in the food, with the constraints that their bio-materiality placed on storage, preservation, distribution, and processing. Their perishability or variability affect the forms of negotiation or contractualisation between actors and involve adjustments and investments to manage them. In the various cases studied, the components of the cropping ecosystems and agricultural produce must be grasped as "actants": parasites, soils, plants, and potatoes "make a difference" (Latour 2005, p. 71). The second proposition that we suggest putting forward on the basis of these observations can be stated as follows: *Biological processes act on market agencing.*

Our third proposition comes back to the idea of distributed agency: *Market agencements are hybrid collectives in which the capacity for action is distributed amongst their human, material, and natural components.* Even though the boundaries between these three categories are far from obvious, as we have established in the first proposition, the important thing is to keep in mind that each component/group of components acts on the other two and is influenced in turn by the other two. Figure 1 depicts this idea. Each of the six relations can be illustrated by our survey findings. So, (1) organic farming standards require farmers not to use chemical pesticides, (3) with the consequence that certain biological entities can have far-reaching effects on production, processing, or market trading conditions. Nevertheless, (2) the human actors invest in equipment (6) that helps them to control certain biological processes, such as those that affect the storage of goods. What is more, (4) they act upon the ecosystems through agricultural practices, such as crop rotation and growing two species together. (5+2) That generates in return the creation of new market devices, such as multi-commodity contracts or sorting equipment, that allow the crops coming out of the crop rotation or multi-cropping scheme to be marketed.

Figure 1. Market agencements' distributed agency




This perspective suggests a research programme built around a fourth statement: *Biological processes weigh upon the different marketization processes.* Here we are referring to the different market formation processes identified in the literature and that Callon, Kjellberg, and their co-authors have reviewed in various publications (Callon and Muniesa 2005, Çalişkan and Callon 2010, Kjellberg and Helgesson 2007, Harrison and Kjellberg 2016, Geiger and Kjellberg 2021). Comparing the lists of processes described in these articles with the situations that we have observed reveals many avenues for future research.

One of these processes, which Callon (2021) calls “market passivaction”, is probably the process for which the need to account for the action of biological entities is the most unavoidable. Callon points this out clearly in referring to the difficult “passivaction of the living” and in defining the living as that which “reproduces itself, develops, and evolves, permanent cellular regeneration being a condition for all these characteristics” (Callon 2021, p. 71). A series of studies carried out in the wake of Callon’s work converges to point out that the definition and stabilisation of the qualities of agricultural produce are constrained by the biological processes at work in the field, on the farm, and in food (Le Velly and Dufeu 2016, Henry 2017, Arnold and Loconto 2021, Wang 2018, Wang 2022, Birch 2019). Wang’s articles show, moreover, that the passivaction efforts made to create international export markets can fail. Bacteria may get around the courses of action that the preservation schemes or devices try to impose on them and make vegetables unfit for consumption (Wang, 2018); and health crises in livestock production may not disappear despite antibiotics and sanitation protocols (Wang, 2022). Some recent studies shows that the same thing can happen for the passivaction of the inputs sold in agriculture (Braun 2021, Le Velly and Moraine 2020). The case of the auxiliary insects used to replace pesticides is a good example of the challenge to take up. Managing to select, produce, transport, and use on a large scale “merchandise” as fleeting and fragile as the larvae of the parasitic wasp *Encarsia* is no mean feat (Bonnaud and Anzalone 2021). None of these studies goes so far as explicitly to envision the actions of biological entities in “market passivaction”. Yet the processes that they describe strengthen our belief in the need to do so more systematically.

With a few rare exceptions (Çalişkan 2010, Freidberg 2010, Bernard de Raymond et al. 2013), The impacts of biological entities on the other marketization processes have been studied even less. The observations that we have presented here show, however, how fruitful paying them more attention can be. They notably enable us to see that the processes that Callon (2021) calls “price formulation” and “organizing market encounters” are affected by biological processes. The living matters, it is taken account of by the actors, even imposes itself on them, to organize supply chains, set prices, and draw up contracts. We have seen how Bio Hauts-de-France’s advisers advocate multi-annual, multi-channel contracts to make it possible to sell the various crops in a crop rotation scheme and how cooperatives and traders come up with safety nets to cope with the qualitative and quantitative variability of harvests. On another level, but still using Callon’s (2021) vocabulary, the first situation described in this article suggests that being able to control certain biological processes is an advantage in

the process of "singularisation" and "detachment" from competition (see also Callon et al. 2002, Le Velly and Goulet 2015). In being able to work with onions and the weeds that accompany them without for all that using synthetic pesticides that are banned in organic farming, certain farmers managed to extract themselves from the head-on price competition that could develop for potatoes. Finally, it is also possible to catch a glimpse of these biological entities' also influencing the process of "configuring exchange agents" (Geiger and Kjellberg 2021). Here the educational work done by the farmers and their representatives to make food processing companies and distributors aware of the biological processes imposed by organic farming rules comes to mind. Biological entities obviously do not act alone in these processes, no more than they do in the previous ones. Nevertheless, here, too, their influence must be pinpointed. The desired acculturation of distributors and industrial firms cannot be understood without bearing in mind the biological processes that are specifically at work in the case studied.

Crossing each of the marketization framings with taking account of the actions of the biological entities involved can ultimately give rise to a series of research questions. Table 1 proposes to do so very succinctly, but relatively comprehensively. Starting from the typologies proposed by Callon, Kjellberg and their co-authors, we identify eight marketization processes and eight research questions associated with them. This inventory leads to several more questions in addition to those that our field survey prompted. By working more on the overall market scale and less on the transactions scale, as we did, we see that it becomes relevant as well to ask about how "normalizing practices" and "representational practices" (Kjellberg and Helgesson 2007) take account of biological processes. Specifically, we might wonder about the absence of biological processes in the norms and representations that the actors have developed on certain markets: Is this due to the lack of biological entities, to processes that have domesticated their actions to the point where it is no longer necessary to account for them, or to processes that have made their actions invisible, even though they are indeed present?

Table 1. How the action of biological entities affects marketization processes: a series of research questions

| Marketization process | References | Research question |
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| | | |
|---|---|---|
| Qualifying merchandise | "Making goods calculable" (Callon and Muniesa 2005), "Exchange practices" (Kjellberg and Helgesson 2007), "Pacifying goods" (Çalişkan and Callon 2010), "Qualifying exchange objects" (Harrison and Kjellberg 2016), "Market passivaction" (Callon 2021) | How are living entities turned into merchandise? |
| Configuring exchange agents | "Distributed calculative agencies" (Callon and Muniesa 2005), "Exchange practices" (Kjellberg and Helgesson 2007), "Marketizing agencies" (Çalişkan and Callon 2010), "Configuring exchange agents" (Harrison and Kjellberg 2016), "Agencies and their qualculative equipment" (Callon 2021) | How does the action of biological entities force or support transformations of exchange agents? |
| Organizing market encounters | "Calculated encounters" (Callon and Muniesa 2005), "Exchange practices" (Kjellberg and Helgesson 2007), "Price-setting" (Çalişkan and Callon 2010), "Organizing market encounters" (Callon 2021) | How does the action of natural entities influence market infrastructure? |
| Price setting | "Calculated encounters" (Callon and Muniesa 2005), "Exchange practices" (Kjellberg and Helgesson 2007), "Price-setting" (Çalişkan and Callon 2010), "price formulation" (Callon 2021) | How does the action of biological entities affect the ways prices are set? |

| | | |
|---|---|---|
| Attachment and detachment | "Making goods calculable" (Callon and Muniesa 2005), "L'affectio mercatus: attachments and detachments" (Callon 2021) | How do biological processes strengthen or weaken attachments and detachments between market components? |
| Establishing norms | "Normalizing practices" (Kjellberg and Helgesson 2007), "Establishing market norms" (Harrison and Kjellberg 2016) | How do biological practices influence the establishment of market norms? |
| Market representations | "Representational practices" (Kjellberg and Helgesson 2007), "Generating market representations" (Harrison and Kjellberg 2016) | How do representations of the market take account of biological processes? |
| Contesting the framings | "Market design and maintenance" (Çalişkan and Callon 2010), "How do market agencements evolve?" (Callon 2021) | How do biological processes become matters of concern that stimulate changes in the way the market is framed? |

**Conclusion**

To sum up, through this article we have proposed taking a fresh look at all the marketization processes identified in the literature. For each of them, the ways biological entities affect the course of production and market actions must be taken seriously. Let us point out that such a perspective probably involves increasing the multidisciplinarity of market studies. This field of research has already benefited from various contributions from different fields: economic sociology, science and technology studies, and management studies. Taking an original tack, we plead in favour of examining complementary contributions from ecology, crop science, soil science, agri-food processing, and other life sciences. Let us add, to wrap up, that in our opinion such a concern has more than scientific merit, that of being able to support a better understanding of markets, connecting them tightly to production practices and biological processes. It can also be considered through its political implications. Callon (2021) defends the idea that market sociology must be used to engineer more desirable markets and Latour has long supported the idea that ANT must enable us to change the way we tackle ecological

issues (Latour 2004, see also Bennett 2010). In treating head-on the way that biological, material, and social processes intertwine, we think that our propositions can support a less asymmetrical and anthropocentric view of markets than the ones that usually prevail.

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**References**

Arnold, N. and Loconto, A. 2021. Serving Magically Perfect Fruit Globally: Local nesting in translating multiple standards. *Organization Studies,* 42(2), 327-349.

Barua, M. 2017. Nonhuman labour, encounter value, spectacular accumulation: the geographies of a lively commodity. *Transactions of the Institute of British Geographers,* 42(2), 274-288.

Bennett, J., 2010. *Vibrant matter. A political ecology of things.* Durham and London: Duke University Press.

Bernard de Raymond, A., Bonnaud, L. and Plessz, M. 2013. Les fruits et légumes dans tous leurs états. La variabilité, la périssabilité et la saisonnalité au cœur des pratiques sociales. *Revue d'études en agriculture et environnement,* 94(1), 3-12.

Birch, K., 2019. *Neoliberal Bio-Economies? The Co-Construction of Markets and Natures.* Cham: Palgrave Macmillan.

Bonnaud, L. and Anzalone, G. 2021. A perfect match? The co-creation of the tomato and beneficial insects markets. *Journal of Rural Studies,* 83, 11-20.

Braun, V. 2021. Holding on to and letting go of seed: quasi-commodities and the passage of property. *Journal of Cultural Economy,* 14(3), 306-318.

Busch, L., 2011. *Standards: recipes for reality.* Cambridge: MIT Press.

Çalişkan, K., 2010. *Market threads. How cotton farmers and traders create a global commodity.* Princeton: Princeton University Press.

Çalişkan, K. and Callon, M. 2010. Economization, part 2: a research programme for the study of markets. *Economy and Society,* 39(1), 1-32.

Callon, M., 1986. Some elements of a sociology of translation. Domestication of the Scallops and the Fishermen of St. Brieuc Bay. *In:* Law, J. ed. *Power, Action and Belief. A new Sociology of Knowledge?* London: Routledge, 196-223.

Callon, M. 1998. Introduction: the embeddedness of economic markets in economics. *The Sociological Review,* 46(S1), 1-57.

Callon, M., 2021. *Markets in the Making: Rethinking Competition, Goods, and Innovation.* Princeton: Princeton University Press, Zone Books.

Callon, M. and Law, J. 1995. Agency and the hybrid "collectif". *The South Atlantic Quarterly,* 94(2), 481-507.

Callon, M., Méadel, C. and Rabeharisoa, V. 2002. The economy of qualities. *Economy and Society*, 31(2), 194-217.

Callon, M. and Muniesa, F. 2005. Economic Markets as Calculative Collective Devices. *Organization Studies*, 26(8), 1229-1250.

Cochoy, F., 2015. *On the origins of self-service.* Milton Park: Routledge.

Cochoy, F., Trompette, P. and Araujo, L. 2016. From market agencements to market agencing: an introduction. *Consumption Markets & Culture*, 19(1), 3-16.

Delvenne, P. 2020. Suspended commodification: assetization and the politics of silobolsa in Argentine soybean agriculture. *Journal of Cultural Economy*, 14(3), 1-13.

Freidberg, S., 2010. *Fresh: A perishable history.* Cambridge, MA: The Belknap Press of Harvard University Press.

Geiger, S., *et al.*, eds., 2014. *Concerned markets. Economic ordering for multiple values.* Cheltenham: Edward Elgar.

Geiger, S. and Kjellberg, H. 2021. Market mash ups: The process of combinatorial market innovation. *Journal of Business Research,* 124, 445-457.

Goulet, F. and Vinck, D., 2017. Moving towards innovation through withdrawal: the neglect of destruction. In: Godin, B. and Vinck, D. eds. Critical Studies of Innovation: Alternative Approaches to the Pro-Innovation Bias. Cheltenham: Edward Elgar Publishing, 97-114.

Harrison, D. and Kjellberg, H. 2016. How users shape markets. *Marketing Theory*, 16(4), 445-468.

Henry, M. 2017. Meat, metrics and market devices: Commensuration infrastructures and the assemblage of 'the schedule' in New Zealand's red meat sector. *Journal of Rural Studies*, 52, 100-109.

Ingold, T., 2011. *Being Alive. Essays on movement, knowledge and description.* London and New York: Routledge.

Ingold, T. 2012. Toward an Ecology of Materials. *Annual Review of Anthropology*, 41(1), 427-442.

Ingold, T. 2000. *The Perception of the Environment. Essays on livelihood, dwelling and skill*. London and New York: Routledge.

Kjellberg, H., Azimont, F. and Reid, E. 2015. Market innovation processes: Balancing stability and change. *Industrial Marketing Management*, 44(1), 4-12.

Kjellberg, H. and Helgesson, C.-F. 2007. The mode of exchange and shaping of markets: Distributor influence in the Swedish post-war food industry. *Industrial Marketing Management*, 36(7), 861-878.

Latour, B., 1999. *Pandora's Hope. Essays on the Reality of Science Studies.* Cambridge, Mass.: Harvard University Press.

Latour, B., 2004. *Politics of nature. How to bring the sciences into democracy.* Cambridge, Mass.: Harvard University Press.

Latour, B., 2005. *Reassembling the social: an introduction to actor-network-theory.* Oxford: Oxford University Press.

Le Velly, R. and Dufeu, I. 2016. Alternative food networks as "market agencements": Exploring their multiple hybridities. *Journal of Rural Studies,* 43, 173-182.

Le Velly, R. and Goulet, F. 2015. Revisiting the importance of detachment in the dynamics of competition. *Journal of Cultural Economy,* 8(6), 689-704.

Le Velly, R. and Moraine, M. 2020. 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,* 37(4), 999-1012.

Legun, K. A. 2015. Club apples: a biology of markets built on the social life of variety. *Economy and Society,* 44(2), 293-315.

Lemke, T. 2021. Welcome to Whenever: Exploring Suspended Life in Cryopreservation Practices. *Science, Technology, & Human Values*, online first.

Lorimer, J., 2020. *The Probiotic Planet – Using Life to Manage Life.* Minneapolis: University of Minnesota Press.

MacKenzie, D. 2009. Making things the same: Gases, emission rights and the politics of carbon markets. *Accounting, Organizations and Society,* 34(3), 440-455.

MacKenzie, D., 2021. *Trading at the Speed of Light: How Ultrafast Algorithms Are Transforming Financial Markets.* Princeton: Princeton University Press.

Moser, C., *et al.* 2021. Biomateriality and Organizing: Towards an Organizational Perspective on Food. *Organization Studies,* 42(2), 175-193.

Muniesa, F., Millo, Y. and Callon, M., 2007. An introduction to market devices. *In:* Muniesa, F., Millo, Y. and Callon, M. (Eds.). *Market devices.* Oxford: Blackwell, 1-12.

Murdoch, J. 1997. Inhuman/Nonhuman/Human: Actor-Network Theory and the Prospects for a Nondualistic and Symmetrical Perspective on Nature and Society. *Environment and Planning D: Society and Space,* 15(6), 731-756.

Neyland, D., Ehrenstein, V. and Milyaeva, S. 2018. Mundane market matters: from ordinary to profound and back again. *Journal of Cultural Economy,* 11(5), 377-385.

Onyas, W. I. and Ryan, A. 2015. Agencing markets: Actualizing ongoing market innovation. *Industrial Marketing Management,* 44(1), 13-21.

Ouma, S., 2015. *Assembling export markets. The making and unmaking of global food connections in West Africa.* Oxford: Wiley.

Pinch, T. and Swedberg, R., eds., 2008. *Living in a Material World. Economic Sociology Meets Science and Technology Studies.* Cambridge MA: The MIT Press.

Radin, J. 2013. Latent life: Concepts and practices of human tissue preservation in the International Biological Program. *Social Studies of Science,* 43(4), 484-508.

Sayes, E. 2013. Actor–Network Theory and methodology: Just what does it mean to say that nonhumans have agency? *Social Studies of Science,* 44(1), 134-149.

Vatin, F. 2013. Valuation as Evaluating and Valorizing. *Valuation Studies,* 1(1), 31-50.

Wang, C.-M. 2018. Assembling lettuce export markets in East Asia: Agrarian warriors, climate change and kinship. *Sociologia Ruralis,* 58(4), 909-927.

Wang, C.-M. 2022. Securing participation in global pork production networks: biosecurity, multispecies entanglements, and the politics of domestication practices. *Journal of Cultural Economy*, 15(2), 200-215.