Article

Implications for Agricultural Producers of Using Blockchain for Food Transparency, Study of 4 Food Chains by Cumulative Approach

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Abstract: In agro-food, Blockchain has been recently implemented in order to improve transparency. Blockchain raises great expectations of data decentralization and better efficiency–cost ratio, integration speed, and data protection that appear as promises of gains in all areas. The fundamental assumption was that transparency prevents or reduces illegitimate forms of power. However, discussions are emerging about how digitization is likely to exacerbate power inequalities in food systems, as transparency can become tyrannical when it contributes to the proliferation of audits, evaluations, and assessment measures. The objective of this research is to contribute by providing knowledge about the implications of this digitization for farmers. For a first exploratory study, we conducted 53 interviews with actors of digitalization of agri-food, and we used 9 press releases, 3 webinars, and 1 article published in a specialized French journal. These materials evoke 12 different agro-food chains recently equipped with blockchain in France. From this pool of chains, we focused on four through in-depth analysis of interviews and literature readings using NVivo software. The first results highlight that the use of blockchain for transparency rarely delivers on its promises. Blockchain tends to centralize control since few actors have access to the distributed ledger, and the visibility brought to farmers, at the consumer level, tends to become a form of control. While blockchain seems to provide some benefits to producers, it raises the issue of overloaded technology and the problem of their data privacy.

Keywords: blockchain; food chain; transparency; panopticon; food governance; food discourse; farms; farmers

1. Introduction and Background

1.1. Food Scandals and Demand for Transparency

Various food scandals have occurred since the 1990s [1]. These scandals have led to a resonance to the dissociation between agriculture and food for consumers [2]. Horse meat found in beef lasagna in 2013 and infant milk contaminated with salmonella in 2017 have rekindled this impression.

Considering other scandals such as the collapse of Enron, manipulation of Volkswagen's emissions tests, or whistleblowers such as the Snowden and WikiLeaks cases [3], stakeholders' transparency seems highly in demand in many sectors [4]. Transparency is often cited as crucial to the trust that stakeholders place in organizations [5]. In the food sector, low levels of transparency and the hegemony of large corporations seem to be of concern for society [6].

During the Bovine spongiform encephalopathy crisis, consumers resorted to "reciprocal action" and "personal knowledge" to regain some confidence in what they were

buying [7]. The need to regain consumers' trust based on their personal knowledge has been reflected in their growing interest of "traceability". The need for trust in the food sector became a key issue after the beef scandal. This need has spread to other commodities/products. Nowadays, it emerges in new forms: the establishment of "Association pour le Maintien d'une Agriculture Paysanne (AMAP)" and the emergence of the trend "locavore" lead to this direction. Choosing local products and reducing the number of intermediaries between producers and consumers improve the consumers' knowledge about the products and its producers [7].

1.2. Link between Trust and Transparency

In general, modern societies are going through a crisis of trust [8], as people do not believe what the media says about the food industry [9]. Trust and reliability are perceived as an essential determining factor of a good relationship between buyers and sellers [10].

Reshaping the rhetoric of "consumer's mistrust," food industry players are leveraging consumer fears to implement "transparency" projects by using blockchain. These projects aim to give consumers visibility and transparency of every process in production "from field to plate". Photos and videos of farmers in their farms are feeding blockchains. These processes would contribute to the transparency of products. However, the concept of blockchain at the beginning would be to replace the trust in official institutions, [8,11,12] and thus it proposes an alternative way to substitute them. Therefore, this technology would be conducive to solve the trust issues in the sharing economy. In other words, and in some contexts, the blockchain can be adopted to replace trust. These "trustless" blockchain-based systems promise to revolutionize peer-to-peer interactions. Typically, this high degree of trust was facilitated by third-party providers [11]. This new technology would therefore "outsource" trust and regain consumer confidence.

It is difficult for the food industry to make producers and consumers closer. Blockchain is used to make consumers feel closer to producers. Beginning in 2016, in response to food scandals, specifically following the contamination of spinach sold in the United States, retail giant Walmart addressed the safety, traceability, and transparency of its supply chains by using blockchain technology [13–15]. This technology works, in theory, as a distributed ledger of data shared among several users. The blockchain has three desirable characteristics: the decentralization of data or the removal of trusted third parties, the cost-efficiency or the integration speed of information in the blockchain, and the data integrity, meaning it is difficulty to modify the data. These characteristics can only be combined two by two: it is possible to obtain a blockchain technology with data integrity and decentralization, or a blockchain with integrity and cost-effectiveness, but it is impossible to have all three of these characteristics simultaneously. Decentralization and cost efficiency do not seem to be reconcilable [16]. In agri-food, the blockchains implemented combined cost-effectiveness and data integrity.

Without a desire to address this specific health safety issue, Carrefour has followed this movement to bring more "transparency" to its products [17–19] and sets the ambition to apply "blockchain" for all the products of its "Filières Qualité".

1.3. Digitization of Value-Chains and Power

At the same time, discussions are emerging about how digitization is likely to exacerbate power inequalities in food systems [20–25]. Studies conducted by social scientists on digital agriculture, on-farm production systems, value chains, and food systems are still unknown and relatively recent [26].

According to a study conducted by IDDEM for OKP4 on farmers' willingness to "liberate" their data, data missuses is feared by nearly 70% of them and commercial use of data is feared by one in two farmers. They see hacking and abuse (of their data) as potentially damaging the image of agriculture or influencing markets. These findings corroborate with the social science literature that identifies digital data in agriculture as affecting agricultural producers' identity, skills, and their works [26]. Within the discussions of so-called "smart"

agriculture and digital agriculture, the examination of farmers' concerns is often missing. These stakeholders are not reassured about how their agricultural data is collected and managed. Key concerns that may discourage them from sharing their data, include lack of clarity and transparency about the terms of use of their data; data ownership issues; protection of their privacy; unequal bargaining power; and lack of benefit sharing [27]. Similarly, in the short to medium term, concerns about transparency, equity in terms of benefit sharing, data ownership, as well as data access seem to dominate among farmers [28].

It seems that the actors initiating the use of blockchain for the transparency of chains in France or the EU do so by constructing and fabricating the need for consumer "reassurance" [29] to legitimize their projects. Businesses adopting blockchain in food chains are sometimes perceived to have a lack of deep understanding of the technology, which may compromise the benefits associated with its use. In other words, it appears that the technology is being used for purposes other than the problems it is likely to solve [30]. Some authors argue that it would ultimately consist of technological solutionism [8] and others hypothesize "technology hype" [31]. For instance, investors would confuse bitcoin and blockchain, and sometimes they use bitcoin performance as an indicator of the expected success of blockchain technology [32] or blockchain-backed projects. Finally, research points out that, to date, case studies on the use of blockchain for food safety tend to focus on the study of blockchain for food traceability but neglect the question of the implications of blockchain for the control of food chains [33].

2. Research Questions

Some predict that this new technology will be a tidal wave with consequences greater than what we experienced with the Internet 20 years ago [34] (p. 67). Industrial use of blockchain is still in its infancy [12,14]. Some authors point out that it can create transformations in businesses and supply chains [35]. It is described as potentially "disruptive" [35] and would be associated with a viable system of transparency, traceability, and security [35,36]. The majority of existing studies have focused on the application of blockchain in the financial sector, which limits the scope of findings for other sectors [37]. Most of the research has a primarily technological orientation. In other words, they focus on the technical aspects of the blockchain, and they ignore the organizational complexities of its implementation [37] or the human issues.

By its architecture alone, blockchain is supposed to guarantee transparency, traceability, and data security [35], but in the literature, there is a lack of proof for these three qualities. Therefore, it is difficult to know whether blockchain is a good or a bad technology for the stakeholders in the agri-food sector.

The current research does not aim to answer the question of transformation [38], enhancement [39], transferability [40], or spillover from the use of blockchain [41,42] for food transparency, nor does it aim to capture the barriers to its adoption [35] and the impediments to its sustainable application [43,44] or identify the relevant uses of the technology [31,41,42].

The objective of this work is therefore to contribute to providing knowledge on the digitization of food systems and more specifically on the implications of this digitization for agricultural producers. Indeed, for farmers, what do the goals of transparency using blockchain lead to? In other words, what are the implications for these actors of using blockchain for the purpose of chain's transparency?

To contribute to these questions, firstly, it is necessary to define transparency (2.1) and what the promises of Blockchain are as a matter of transparency (2.2).

2.1. Transparency

Transparency has become a major theme in management theory, [45–47]. It would even be the key to good governance [48,49]. It would facilitate understanding, and it would stimulate the knowledge and participation of citizens, consumers, and members of organizations. It is considered a democratic practice with great emancipatory potential [50].

This two-way concept combines both openness and surveillance [51]. Transparency can be defined as a "far-reaching organizing principle that significantly influences social behavior," but it can create "new forms of closure, manipulation, control and surveillance" [50]. It is intertwined with political regimes or management trends that some scholars discuss under designations such as "neoliberalism" [48,52,53], "corporate social responsibility" [54], or "visibility policy" [55,56].

It has been shown that transparency can become tyrannical when it contributes to the proliferation of audits, evaluations, and assessment measures [52,53]. We would be entering an era where the objects to be governed must be made visible [57]. Digital technologies exponentially increase the individuals' transparency" [58]. Data-driven forms of transparency can facilitate the establishment of a system that allows an "unlimited power". Transparency is essentially productive, ambiguous, and regularizing [55]. Visibility and disclosure devices do not simply "reveal" what is hidden but construct and manufacture objects of knowledge. The fact that "transparency is governed" refers to the fact that "it is organized within a normative matrix that itself governs how we see and what we see" [47]. This does not mean that individuals accept that visibility which is made of them without revolt [47]. Historically, there have been revolts against "the gaze" [59] (p. 162).

Following in the footsteps of other authors [60], the intention is not to legislate the terminology of "transparency" or define what transparency should encompass or exclude, but to illustrate and criticize the implications of pursuing transparency. Indeed, the literature recommends careful consideration of attempts to promote transparency [60].

2.2. Blockchain for Transparency in Agro-Food Systems

Blockchain would enable transparency while allowing for tracking and monitoring [39]. Blockchain technology is therefore defined as providing transparency. It would be a technology of transparency or even a transparent technology [35,61–66]. This perception of blockchain technology stems from an uncritical understanding of transparency. In other words, transparency would only be synonymous with "making information available", or even synonymous with "accurate information" [4,67–69].

2.2.1. For the Agri-Food-Chain as a Whole including Retailers

According to the literature, blockchain would participate in the digital transformation of many sectors [70]. In agriculture and food, it could increase competitiveness or strengthen market positions [71]. This technology would be able to transform the global food system [72] and would have potential for agri-food chains in improving their performance, food safety [33], food quality, and traceability [30,73]. The use of this technology in food systems can enhance trust and transparency [30] by facilitating information sharing among food chain actors [74]. Information asymmetry between stakeholders is identified as one of the main factors leading to "food fraud" [33]. In this case, blockchain could improve the authenticity of information and speed up food recalls [30]. The characteristics of this technology such as decentralization, security, immutability, and smart contracts would make it capable of improving the sustainable management of food chains [30]. These contracts are computer programs that incorporate the terms and conditions of a contract between two or more parties. Entirely self-applicable and self-executing, they are supposed to eliminate the need for interpretation and subsequent human intervention [75]. For example, they allow users to schedule in advance the execution of a transaction (monetary or information) automatically according to predefined criteria, which can be sustainability criteria.

For supply chain actors, traceability and transparency build better relationships with customers, increase efficiency, and reduce risks and costs associated with potential food recalls, fraud, or loss [72].

2.2.2. For Consumers

By creating traceable and transparent chains, consumers can access information to make informed choices about the food they buy and the companies they support [72]. This implementation significantly affects consumers' purchasing decisions [36].

2.2.3. For Third Parties

For third parties, such as governments and non-governmental organizations, there is not yet a common accepted standard for blockchain. In fact, the main issue of the blockchain would be the lack of protection in corporate trade secrets and data storage [30].

2.2.4. For Farmers

The promise of Blockchain is strengthening market positions [71], but also improving the performance of farmers, food safety [33], food quality, and traceability [30,73]. The use of this technology in food systems can also facilitate information sharing [30]. It can improve the sustainable management of food chains and would build better relationships with customers [72].

3. Theoretical Framework: Foucauldian Approach of Power

For centuries, the fundamental assumption has been that transparency prevents or reduces illegitimate forms of power [55]. The potential of the blockchain is the reduction in the global power of many large corporations, such as multinational institutions, who have an interest in preserving established hierarchies. In other words, the liberating potential of blockchain would be to reduce the power of such companies. As a result, the main risk is that the potential of this technology will be underutilized [76].

However, the increasing opportunities for transparency offered by digital communication technologies have raised surveillance that could centralize control, reinforce entrenched positions, and infringe on privacy. Transparency simultaneously produces and reconfigures power relations in ways that are far more subtle and multifaceted than is typically assumed [55]. Visibility and observation are significant forms of control [56,77,78]. In the interdisciplinary field of transparency studies, Foucault's analysis of the panopticon highlights the "link between power and transparency" and has contributed to the understanding of transparency as "regulating control" [47,55]. Inspired by Jeremy Bentham's vision of a prison in which the inspector is able to see, and thus control, all prisoners at once, [79] describes discipline in modern society as "panopticism".

The panopticon is a prison architecture imagined by [80]. The cells are organized so that the guard can see all the inmates without being seen. The panopticon has ambivalent effects. It allows for empowerment by providing new knowledge and more control but also leads to disempowerment by creating subjection and confinement [81].

Recognizing that the possibility of being observed has self-disciplining effects, Foucault's notion of the panopticon has come to shape many contemporary discussions of the relationship between transparency and control. Drawing on the analysis of the penal institution, transparency equates to centrally managed discipline [55]. Indeed, transparency can be analyzed from the perspective of Michel Foucault's theory of power, which does not view power vertically but rather horizontally. Nevertheless, a power is well and truly operating.

Transparency does not limit or remove power inequalities and does not solve the problems of control through the transmission of information. Instead, it tends to produce new forms of power effects [55]. The panopticon is central to Foucault's (1994) analysis of the dynamics between knowledge and power [82]. It is regularly invoked as a starting point in discussions of surveillance societies [83,84]. In what [79] suggests about the panopticon, observation is clearly implicated in practices of transparency and surveillance [55].

Making something visible with transparency is not simply imposed from above but is rather composed by the interplay of tactics and technologies that act from both above and below. In other words, to understand the intensification of "power through

transparency," one must consider the active subject's participation in establishing that transparency [47]. Moreover, digital technologies are relays of this subjugation in which subjugated individuals end up participating themselves [85]. By using old and new technologies, they actively contribute to making the world more transparent [47]. Indeed, in a process of transparency, the "who" of power remains elusive [55].

In food chains, this technology has already been discussed in terms of the technological expression of a "modern reverse panopticon" [86] or horizontal panopticon [86], whereby the "watched" could become, in turn, "watchers" and the "watchers" the "watched" [86]. In the reverse panopticon, the watched could take on the role of watcher and, conversely, the watcher could be watched [86] in such a way that the surveillance would be shared among several actors and would be voluntary. The horizontal panopticon is characterized by the control and monitoring of all by all on networks through the quest for online visibility [87].

Is the blockchain ultimately a reverse panopticon or does it consist of a "simple" panopticon assigning the roles of "monitor" or "monitored" to the actors of the food chain?

We will use the Foucauldian analysis of the panopticon to understand the risk that the use of blockchain can bring to the transparency of food chains and more specifically, the implications for agricultural producers.

4. Materials and Methods

Faced with the difficulty to access the terrain (due to the size of the structures involved) and a literature that does not present any real case of blockchain in the agricultural and food sector in French territory, an exploratory field was first conducted.

4.1. First Exploratory Study

As the use of blockchain for food chains is particularly reported in the press on the internet, from October 2018, we used this medium to identify the main actors. From January 2019, we contacted a few of them. Thereafter, we used the technique known as "snowball" sampling [88] whereby an interviewee would refer us to a new interviewee. Some interviewees easily passed on the contacts of new interviewees. For those who did not wish to connect us with new respondents, we used the social network LinkedIn to contact new prospects directly when possible.

The first three physical interviews lasted approximately 1.5 h. Subsequent interviews averaged about 30 min in length. From 2020 through April 2021, most interviews were conducted by phone. A total of 53 interviews were conducted, and all of these were transcribed.

We analyzed the data collected from the interviews by first identifying the food chain where the actor interviewed was involved. Second, we searched who was at the origin of the introduction of the Blockchain in the food chain. The results are given Section 5.1.

In total, 12 food chains were identified. Of these, four were subjected to further data analysis, as we felt they were of different types (blockchain introduced by different types of actors and provided by different technical providers), and we had contacts to investigate further if necessary. In addition, we selected these four cases because the first survey provided us with enough data to be sure to obtain interesting results.

4.2. Second Study

For these four food chains, which correspond to four case studies, the people to be interviewed were identified through the first survey. Some of the actors were re-interviewed when possible and other interviews were conducted with new actors.

Most of these interviews were conducted by phone. They lasted between 6 min and 2 h and were transcribed in full. The corpus of data concerning these 4 case studies consists of 14 interviews and 6 documents. Six interviews stem from blockchain suppliers of these chains, 2 interviews with an agricultural trade, 2 interviews with a research organization, 2 interviews with cooperatives, 1 interview with a retailer, 1 interview with an organization

for the defense of appellation and origin, 5 press releases, and 1 article published in a French journal on research in meat products

The case studies are:

- a chicken chain whose blockchain was introduced by a large French supermarket chain;
- a minced steak chain whose blockchain was introduced by a family business;
- a milk chain whose blockchain was introduced by a cooperative;
- a corn chain for popcorn whose blockchain was introduced by the producer and trader.

For the chicken chain, the corpus of data consists of one interview with the retailer, one interview with the organization for the defense of the appellation and origin, one interview with the initial blockchain supplier, one interview with the new technical supplier, one interview with a technical supplier who was particularly familiar with the case in question, and one press release.

For the minced steak chain, the corpus of data consists of one article published in a French trade journal, two interviews conducted with the technical supplier, and one press article on the introducing actor for the food chain.

For the milk chain, the corpus of data consists of one interview with the blockchain provider, one interview with the cooperative group to which the farmers belong, one press release from the cooperative, and one press release from a food industry federation.

For the corn chain, the corpus of data consists of two interviews conducted with the trade, two interviews conducted with a public research organization with which the trade works, one interview with the technical supplier, one interview with a cooperative to which the trade's partner farmers are attached, and one press release on the project.

For this second study, we used an approach by complementary cases study. According to this method, which studies cases cumulatively and not comparatively [89], the cases were selected without a priori consideration of an "ideal situation" or a "successful" situation regarding the use of blockchain in food chains. This approach makes it possible to assume the asymmetry of the data between the cases and the accumulation of different cases makes it possible to extend the understanding of the observed phenomenon. The aim of such work is rather descriptive or comprehensive and corresponds to a holistic approach of a phenomenon. The cases establish an overall view or a generic model that makes it possible to synthesize the situations observed with a view to generalization. The establishment of a generic model will allow for the identification of common lessons [90] for agricultural producers.

Based on the first 53 interviews, an initial manual coding of the verbatims was performed. This open coding identified recurring themes in close relationship with the promise of blockchain, as follows:

1. blockchain is used to find a competitive advantage and helps to find new outlets or increase outlets for agricultural products;
2. blockchain has an impact on the continuity of relationships between chain actors and even creates a certain dependence on them;
3. blockchain has an impact on the price of the product;
4. it also has an impact on the remuneration of agricultural producers;
5. it can transform the way agricultural producers provide traceability information;
6. blockchain does not replace physical meetings between producers and consumers;
7. it has an impact on the way data related to agricultural products are hosted;
8. the geographical locations where data is hosted can vary from one blockchain to another and therefore from one chain to another;
9. the blockchain can be used for purposes other than food transparency;
10. it may require a selection of agricultural producers to contribute to the transparency project;
11. it can accompany a change in agricultural practices or highlight practices that are perceived as sustainable;
12. not all actors in a chain are always direct contributors to the blockchain technology;

13. all the information contained in the blockchain is not always accessible in a uniform manner to all the players in the chain;
14. the implementation of such a system can generate fears and mistrust on the part of agricultural producers.

Subsequently, these themes formed the basis for the analysis of the data related to the four cases studied. These themes were used to code the material from the second study using NVivo.

To interpret our results, we reuse the coding made by [81] de Moya and Pallud (2020) of [79] Foucault's (1977) work on the panopticon. They constructed this reading grid in order to interpret the experiences of users of "quantified-self" technologies [81]. Our work will consist of revealing the elaboration of a panopticon by the implementation of blockchain in food chains, based on the material obtained from the actors at work in the construction of this panopticon. In other words, our approach diverges from [81] de Moya & Pallud (2020) in that it is not based on the direct experience of "user-prisoners", but on that of those who construct the panopticon.

Ref. [81] De Moya & Pallud (2020) point out that the panopticon is composed of four main themes: power, knowledge, body, and space [91]. From these four themes, they identified different "codes" (possible modalities that compose the theme) for each of them.

According to their work, **power** in the panopticon can be broken down into eight codes: the subjection of individuals, its discontinuous aspect, its automatic operation, its simultaneous visibility and unverifiability, the anonymous surveillance it generates, its dissymmetry, the control it can have over the actions of the subjugated, and the control it can have over the thoughts of the subjugated.

"**Knowledge**" is also declined according to five codes as follows: the comparison of the knowledge gathered, the superiority of the supervisor's knowledge (the supervisor has more knowledge and it is superior to that of the other), the discovery of new knowledge, the teaching as the learning of different techniques simultaneously to the subjugated in order to be able to arbitrate which one is the most efficient [79] (p. 203), and the identification, that is to say, the possibility of identifying, at any moment, a problem or an error and knowing who is committing it.

For the "**body**", the authors distinguish five codes: the body can be the object of modification by the transformation of the submissive behavior; it can be the object of prevention in the sense of anticipation of behaviors judged harmful but also of heterogeneity in the sense that not all submissive behaviors are alike; the body can be the object of experimentation and objectification in the sense that it becomes an object of knowledge; and finally, the body of the submissive enters into this idea that it is no longer considered as a thinking subject but as a statistical object.

For the fourth notion implied in the panopticon, "**space**", two ambivalent codes have been identified: the open disciplines and the confinement. The subjugated are confined to their cells and cannot come into contact with each other, but this discipline exercised within the panopticon ensures that it is extended to the whole of a typology of individuals, or even to the whole of society. The extension of this discipline would occur in such a way that the individuals themselves adopt the behavior desired by the power exercised.

In Section 5, our work confirms or refutes the presence of these 20 criteria for understanding the situation of agricultural producers in blockchain-based food chains. Specifically, we will see whether this technology consists of an inverted panopticon [86] or whether it is built like a true panopticon.

5. Results

5.1. Results of the First Study

We display the first results in three sub-sections: the identification of the 12 food-chains, the 8 configurations for the introduction of blockchain, and the 4 ways to put data into the blockchain.

5.1.1. The 12 Food Chains Introducing Blockchain

The data collected from the first range of interviews allowed us to identify 12 food chains having recently introduced blockchain in French agri-food chains. These 12 chains are:

- a corn chain where the "pivotal" or central actor appears to be a corn trader and producer;
- a vegetable chain where a large part of the production is labeled "organic" and where the central actor is also a producer and trader;
- a chain of poultry from a specific geographical area whose central actor is the retailer;
- a honey chain where the cooperative collects honey from all over France and the retailer is the initiator of the blockchain;
- a tomato chain with less than 10 producers in a specific geographical area, where the central actor is the retailer;
- an egg chain protected by a geographical indication and where the blockchain was introduced by the retailer;
- a milk chain where the blockchain project was initiated by the agricultural cooperative;
- a wheat chain with very few producers and where the project was initiated by the agricultural cooperative;
- a duck meat chain whose project was also initiated by the agricultural cooperative;
- a milk chain whose project was carried out by a food brand initiated by the agricultural producers themselves;
- a meat chain in which the actor introducing blockchain is a small food company;
- a chain in the process of being created, where a few producers want to get together to use blockchain to enhance the value of their cereal production without having to rely on labelling or the creation of specifications for an appellation.

5.1.2. The Eight Configurations for the Introduction of Blockchain

From the exploratory study, eight configurations for the introduction of blockchain in the food chain were identified. Blockchain can be introduced by any of the following:

- Retailers, which drive the entire upstream chain to use blockchain;
- Large food companies, which drive the entire upstream chain to use blockchain and expect competitive advantage at retailers' level;
- Family-owned food companies, which drive their suppliers to use blockchain and expect competitive advantage on the market;
- Slaughterhouses, which drive their suppliers to use blockchain and expect competitive advantage on the market;
- Agricultural cooperatives, which drive the farmers to use blockchain and often expect selling them other services linked to blockchain;
- Agricultural traders, who drive the farmers to use blockchain and expect selling them other services linked to blockchain;
- Agricultural producers and traders, who drive the other farmers to use blockchain and also expect selling them other services linked to blockchain;
- Agricultural producers with the support of their union or cooperative, expecting better competitive position thanks to blockchain.

Each of the eight configurations highlight the actor having or wishing to obtain more power in the food chain because of his/her initiative to introduce this new technology, supposedly involving the other actors.

5.1.3. The Four Ways to Put Information in the Blockchain

In none of the 12 food chains, we looked at agricultural producers entering information directly into the blockchain. One of the rare cases where an agricultural producer may be required to enter this information directly is when he/she performs a trading activity him/herself. In this case, he/she also fills in the information on behalf of the farmers from whom he/she buys the product.

In fact, in many situations, the blockchain does not change the "classic" traceability tasks already performed by farmers. The usual information they provide is used to feed the blockchain at a stage of transmission, sometimes without their awareness.

In some situations, the required format of usual information can become digital. Following the implementation of the blockchain, farmers are sometimes required to fill in the same data as before about their production or breeding by using digital tools such as their smartphone or touch tablets. The information collected in digital format will then be entered into the blockchain.

Depending on the situation, the data collected at the producer level can be entered into the blockchain either by the technical service provider or the technology provider, the cooperative, or the trader.

The data is entered by the agricultural cooperative or the trader in two situations: either the cooperative or the trader was the introducer of the chain, or the technical provider of the blockchain has given them direct access to the blockchain. A few players (mostly cooperatives) have mentioned that they would like to equip farms with sensors, in the expectation data to be transmitted directly to the blockchain. Nevertheless, not all cooperatives enter information directly into the blockchain.

As far as access to the direct input of data into the blockchain is concerned, in many situations, only one actor is in possession of this direct access (or sometimes two actors in the food chain at the maximum). This means that these actors are entering data on behalf of other actors. The blockchain certainly presents different blocks of information, but these different blocks do not mean that there is a different contributor to each one. A single actor may be responsible for the creation of different blocks.

In some cases, the actor who has access to the registry information, the introducing actor, and/or the technical provider has an advantage over the other actors because he/she has access to all of the information transmitted by the others. The other actors in the food chain do not know each other's data and information. In other words, one actor of the food chain is in possession of more information than the others.

To conclude this first part of the results, it was possible to identify four possible ways to put information in the blockchain for food transparency:

- Sometimes, the actor of the chain initiating the blockchain's implementation is also the only one who informs it;
- Other times, only two actors of the food chain enter information directly into the blockchain;
- In some other cases, it is the technical service provider who puts information into the block;

In another case, it is the "processing" or "slaughtering" partner that fills in the data in the blockchain, while the initiating actor is a food company founding a product brand, for example.

Furthermore, according to the interviews conducted, the data transmitted in the blockchain is in the form of information. In other words, the blockchain does not arrange the data in a way that creates meaning and information. The content entered is in the form of information on its own. The blockchain is not used to create meaning from data.

5.2. Results of the Four Case Studies

In this section, we will explore the results for four food chains. The first is a poultry chain in a specific geographical area where the central actor is the retailer. The second is a corn chain where the "pivotal" or central actor appears to be a trader and corn producer. The third is a milk chain where the blockchain project was initiated by the agricultural cooperative. Eventually the fourth is that of a meat chain in which the actor introducing blockchain is a small food company.

First, we will show what structurally differentiates the four cases in question (Section 5.2.1). Then, we will present the essential information retained by means of a coding of the material

(Section 5.2.2). Finally, we will establish links between these inductively obtained results and the panopticon framework (Section 5.2.3).

5.2.1. The Four Cases Are Structurally Different

In relation to three of the four ways of putting data into the blockchain (categories mentioned in the previous section), we relate each of these four food chains in the following way (Table 1):

Table 1. Different ways of putting information into the blockchain.

Studied Cases	Who Informs the Blockchain?
A poultry chain in a specific geographical area where the central actor is the retailer	The actor of the chain initiating the blockchain is also the one which informs blockchain
A corn chain where the "pivotal" or central actor appears to be a trader and corn producer	The actor of the chain initiating the blockchain is also the one which informs blockchain
A milk chain where the blockchain project was initiated by the agricultural cooperative	The technical provider fills the information in the blockchain, and the initiating actor is another one
A meat chain in which the actor introducing blockchain is a small food company	The processing/slaughtering partner fills the information in the blockchain, and the initiating actor is another one

For the chicken chain studied, the actor who initiated the blockchain project is also the one in charge of entering the information into the blockchain. In other words, other actors in the food chain are in charge of transmitting the information that will be entered into the blockchain by the retailer.

In the case of the corn chain, it is also the initiating actor who enters the information into the blockchain. In other words, the trader and producer is responsible for entering the information sent to him by his "partner" farmers and other potential players in the chain, such as the transporter.

For the milk chain, blockchain has been introduced by the agricultural cooperative. This time, it is the technical provider who is responsible for providing the information based on data transmitted by the cooperative. In other words, the cooperative collects the necessary information at the farmer level. It then sends it to the technical service provider who is responsible for entering it into the blockchain.

For the meat chain, the initiating actor is a recent company in the sector. Here, it is the slaughterhouse that is in charge of entering the necessary information into the blockchain.

Following the complementary case approach, we selected these four case studies because they have very distinct contextual elements. The four cases selected for the study do not address the situation where two actors in the food chain are direct contributors to the technology. The poultry and corn chains appear to work similarly at first glance, but there are other distinguishing features, as highlighted in the Table 2:

What distinguishes the chicken chain and the corn chain is that in the chicken chain, the initiating actor has become "autonomous" in terms of blockchain provisioning, whereas the corn chain uses an external provider. Among other different characteristics, what distinguishes the milk chain and the meat chain is that they do not use the same blockchain protocol.

5.2.2. Analyses of Discourses Thanks to an Inductive Coding

We analyzed the data from these four study cases from the codes identified during the open coding carried out following the first exploratory study. We kept only the codes for which we had enough data (so, we eliminated the codes 2. blockchain has an impact on the continuity of relationships between chain actors; 3. blockchain has an impact on the price of the product; 6. blockchain does not replace physical meetings producers/consumers; 14. blockchain can generate fears and mistrust on the part of agricultural producers).

Table 2. Technical provider and protocol in use for the four studied cases.

Studied Cases	Technical Provider	Blockchain Protocol Used
A poultry chain in a specific geographical area where the central actor is the retailer	Currently, the actor of the chain which initiated the blockchain is also his own technical provider	Hyperledger
A corn chain where the "pivotal" or central actor appears to be a trader and corn producer	The technical provider in blockchain for this trader is a software integrator	Hyperledger
A milk chain where the blockchain project was initiated by the agricultural cooperative	The technical provider in blockchain is a specialized company	Hyperledger
A meat chain in which the actor introducing blockchain is a small food company	The technical provider in blockchain is a specialized company	Ethereum

The results are summarized in Tables 3 and 4. The Table 3 gathers the verbatims relevant to the main results relating to the management of information to be entered into the blockchain, while Table 4 looks more specifically at the consequences of blockchain introduction for farmers.

Table 3. Operating characteristics of the blockchain in the four studied cases.

	Ways to Transmit Information for Producers	Actor in Charge of Hosting Data	Actor in Charge of Entering Information into the Blockchain	Location of Data Hosting	Actor in Charge of Partitioning the Information in the Blockchain
Poultry Chain	Unchanged information transmission practices for agricultural producers; initially had to provide photos and videos showcasing them.	The retailer (initiating actor)	The retailer is responsible for entering information into the blockchain based on what each of the actors in the chain has reported to him.	Data hosted in the USA	The retailer isolates certain information between the actors in the chain. The information never "returns" to the previous actor.
Corn Chain	The selection of producers participating in the project was based, among other things, on their possession of a smartphone to be able to transmit digitized data.	The trader (initiating actor)	The trader is responsible for entering the data into the blockchain from the information provided by the producers.	Data hosted in the USA	The trader receives all the information from his partners, but they do not know the information provided by their peers, and the trader does not provide information on his own production to his partners.
Milk Chain	NA	The technical provider	The technical provider is responsible for entering the data into the blockchain.	Data hosted in the USA	The cooperative transmits all the information given by the farmers to the technical provider, but the producers do not have access to the information of their peers or of the cooperative.
Meat Chain	Producers are not aware that the information they transmit is entered by the slaughterhouse into a blockchain.	The slaughterhouse's server	The slaughterhouse is in charge of entering the information of the actors in the chain into the blockchain.	Data hosted in EU	The producers do not have access to the information of the other actors in the chain (even if they can have most of the information if they scan the QR code of the packaging).

Table 4. Consequences of the introduction of the blockchain for farmers in the four food chains.

	Market Opportunities	Producers' Remuneration	Blockchain Used for Purposes other than "Transparency"	Selection of Agricultural Producers	Communication on "Sustainable" Practices Using Blockchain
Poultry Chain	New opportunities for the food chain's upstream due to their initial plan for additional information using a QR code and the retailer's blockchain project.	Better forecasted remuneration due to this increased market opportunity.	NA	All producers in the initial chain (before blockchain) participate in the project.	Highlighting of practices considered "virtuous" by manufacturers but not labelled. The communication of well-selected information to consumers makes it possible to mask the "industrial" dimension.
Corn Chain	Blockchain is part of the creation of a new chain through the creation of a new product brand.	The blockchain is part of a desire to rationalize the allocation of financial compensation for practices considered "agroecological".	Blockchain used to formalize proof of the realization of "agro-ecological" practices and thus to create a "high added value" food chain (strategy of production segmentation).	Only about 50 producers were selected to contribute to the project (about 200 producers had applied).	Highlighting of "agroecological" practices followed on a voluntary basis initially.
Milk Chain	Better value of the product price to the downstream market.	Better remuneration for producers.	The blockchain is being used as part of the cooperative's wider digitization projects. The blockchain would support the future collection of farm data, which would aim to certify "virtuous" agricultural practices and sell new services to the cooperative's farmers.	NA	NA
Meat Chain	The blockchain supports a project to create a value chain and a brand of food product.	Better remuneration for agricultural producers is assumed because of the potential new outlets.	NA	NA	NA

Regarding the ways of transmitting traceability information for agricultural producers, the situations are either unchanged or they use a digital tool that allows them to create an already digitized information. On the other hand, they may be asked to make an extra effort, such as providing photos or videos, while at other times they are not aware that certain information, such as the address of their farm, is populated in the blockchain and available to consumers.

Regarding the actor in charge of hosting the data, the situations vary. It can be the initiator of the project, the technical provider, or a specific actor of the blockchain. The actor in charge of hosting the data is also the one in charge of entering the information directly into the blockchain. The data is hosted on the American continent or in Europe depending on the blockchain protocol used.

In any case, farmers do not have access to the information entered in the blockchain. In other words, the information is always top-down within the food chain and never bottom-up. Indirectly, farmers provide information that is inserted into the blockchain but cannot access that of their peers or the next actors in the food chain.

Concerning this part, some information is missing due to the facts that either the project is too recent, or that the information was not communicated by the actors concerned, or that the various statements are too contradictory.

Regarding market opportunities, blockchain allows actors to gain new outlets or create new food chains. Because of these new markets, producers can increase their

remuneration. Nevertheless, for one of the chains we met, blockchain was initiated with the aim of rationalizing the financial compensation granted to farmers. This increase in their remuneration is therefore half-hearted. Moreover, as the quantity of agricultural products is often relative to their price, it is likely that for many productions, the opportunities' increase will result in an increase in the size of the farm. For the milk chain, however, the cooperative has managed to increase the value of the bottle at the retailer level. In fact, this project does lead to an increase in the remuneration of dairy farmers.

On the other hand, the main motivation presented in the literature or by chain actors for using blockchain is to provide more information to consumers or to generate a certain transparency. In other words, blockchain could be a simple "product innovation". However, we can see that these projects can be backed by other purposes. The dairy cooperative wants to see its members' farms equipped with sensors so as to make data collection automatic for the blockchain but above all to be able to sell advice on precision agriculture to farmers. These new services could well negate the benefits of their additional compensation.

As blockchain is used to rationalize financial compensation for corn farmers based on their "agro-ecological" practices, it may have the effect of segmenting a food chain between "agro-ecologically" grown corn and the rest of the corn. In this sense, blockchain can accompany market segmentation projects.

In addition, in certain situations, a selection of agricultural producers participating in the project is set up, which contributes to the segmentation purpose. On the other hand, when no selection is established, as in the case of the chicken chain, it is certainly because the segmentation was carried out before the use of blockchain.

In this idea of market segmentation, the blockchain can therefore be used either to highlight practices considered "virtuous" by the industrialists themselves and which were already practiced by all the producers in the chain or to highlight "agroecological" practices previously followed on a voluntary basis. It can be assumed that, subsequently, the use of blockchain will encourage producers to use these practices.

5.2.3. Coding of Results by the De Moya & Pallud (2020) Framework on the Panopticon

To shed light on our inductively obtained results, we took up the analytical grid developed by [81] de Moya de & Pallud (2020) on the panopticon metaphor analyzed by [79] Foucault (1977) and depicted in Section 4.2. Our work consisted in attaching each of the codes identified by the authors on power, knowledge, body, and space to the elements classified in Section 5.2.2 (Tables 3 and 4). This new classification is presented in Appendix A.

Power: Regarding the code on "individuals' subjection", blockchain projects confine producers to their production role. They are subject to provide additional communication about their products but are not actors in this communication. They do not obtain additional information on the chain despite their indirect participation in the blockchain, which restricts them to a role as a productive actor.

Some aspects of these projects may escape them (such as the way in which the data is hosted or the type of information entered in the blockchain). In this sense, blockchain has the character of "objectification" of individuals present in the panopticon. According to this characteristic, the subjects are seen but can never in turn "see". In this sense, it attributes a "visible and unverifiable power" because it is often a single actor who has access to all the information in the chain. The visibility of this power is accentuated by the possibility for certain actors to select the producers who will be part of the project.

"Anonymous monitoring" of producers can be generated because they pass information to certain actors but do not always know explicitly which other actor will have this information and for what purpose. In addition, some technical providers are thinking of developing an activity to assist or substitute for the audit activity via the blockchain's provision.

With respect to the "discontinuity of power" that blockchain may exert, at this stage, this power is relatively weak. What is collected at the farm level is more similar to information than data and therefore cannot do without manual input. Nevertheless, if some projects end up using automatic data collection technologies, blockchain will be able

to exercise a "discontinuous power" over farmers in the sense that surveillance will be permanent in its effects but discontinuous in its actions [79] (p. 201).

For the "automatic functioning of power" that blockchain is likely to exercise, it can take on this character when it serves, in addition to transparency, to measure certain actions carried out on the farm. For example, when blockchain is used to rationalize the financial compensation awarded to farmers for their agroecological practices, it tends to enjoin them to follow these practices.

This technology highlights an already existing "power asymmetry" between actors in food chains. In some situations, blockchain gives greater power to the technical service provider, who constitutes a kind of new actor within the chain. This actor tends to hold more power when he is responsible for entering information into the blockchain himself. This actor ends up knowing more than the agricultural producers even though he was not part of the chain itself in its former configuration.

Sometimes the slaughterhouse or the "processing" partner enters the data into the blockchain even though they were not the "iproject's" initiators. This can be explained by the fact that this type of actor certainly holds a lot of power in the food chain. Even if the project was initiated by another company, the fact that another actor is feeding data into the blockchain certainly shows that this actor has a lot of power among the other actors.

As for the "comparison" of individuals exercised in the panopticon, this can be found in blockchain projects. When the actor introducing the blockchain and in charge of hosting the data is both a producer and a trader of agricultural products, he is likely to compare his farm with those of his partner farmers. On the other hand, it was mentioned that blockchain is likely to generate "market segmentation" strategies. Market segmentation involves product differentiation, which is based on a comparison of agricultural products.

Knowledge: In the panopticon, the "knowledge of the supervisor is superior" to that of the prisoners. In the use of blockchain for food transparency, in the cases studied, we find one actor who knows more than the others. In terms of "discovering new knowledge", some actors who do not belong to the food industry, such as technical suppliers, can learn more about the functioning of chains. The knowledge is growing, especially when they are in charge of filling in the information in the blockchain. Aiming to provide more information about the products for the consumers, these projects can also provide them more knowledge. In fact, the actors most affected by this provision of knowledge are the agricultural producers.

In the panopticon, "different techniques can be taught" to individuals in order to define which one is the most efficient [79] (p. 203). The cooperative's plan to develop the sale of advice about precision agriculture to farmers by combining "automatic data collection and blockchain" could consist of learning new production techniques in order to improve farm performance. On this issue, the panopticon implies "anticipation or prevention" in the prisoners' behavior. This advice could contribute to prevention with the help of blockchain and some experimentation practices. These features will be enhanced by the connected objects' use.

Regarding "immediate recognition or identification," blockchain contributes to the possibility of identifying farmers. Consumers can have access to the precise address of the farm. In the panopticon, subjects are encouraged to "transform their behavior" to conform to the power and surveillance exercised. In the blockchain, at this stage, it is rather the other actors in the chain, and in particular the supervisors, who are led to modify their behavior by equipping themselves with the technology and by providing information. Nevertheless, in certain situations, producers must fill in a certain amount of information with a digital tool, which represents a change.

Body: Foucault refers to the "bodies' heterogeneity" in the Panopticon [79] (p. 208). On this aspect, we note that blockchain erases the singular characteristics of farms or is set up for relatively homogenous groups of farms. In other words, it supports standardization logics.

Regarding the practices of "unlocked disciplines", these consist in making the disciplines that take place within the panopticon deborder in such a way that they reach the whole social body. None of the information from the collected material confirms that blockchain leads to this type of disciplinary propagation. What could confirm or deny this would be to collect information from food industry actors not using this technology. This would allow us to know if the use of blockchain by competitors or partners has repercussions on their practices.

There is no information to encode the "power over thoughts" that blockchain for food transparency may have on agricultural producers. This can be explained by the material collected and the way these projects are implemented. Indeed, it was impossible to collect testimonies from farmers in the relevant food chains because the other actors in the chains were opposed to it. As far as blockchain projects are concerned, they may not generate control over farmers' thoughts because the projects are still recent, may be intertwined with other projects, and, above all, the data collection is not automated.

Space: Finally, in the panopticon, a certain "confinement" is exercised so that the prisoners do not see each other. In the use of blockchain for food transparency, this confinement is also exercised among farmers since they do not have access to the information entered in the blockchain and cannot know the information from their peers. On another level, the information in the blockchain is always top-down but never bottom-up. In fact, farmers do not see the information added by other actors in the chain.

Concerning the results on new opportunities, the improvement of farmers' remuneration and the selling price of products, the 20 codes of the panopticon do not allow to link these elements to one of them. Nevertheless, it sheds light in terms of decisions to be made on blockchain implementation in food chains.

6. Discussion and Conclusions

As the industrial use of blockchain is still in its infancy [12,14], this may explain some underutilization of the technology's potential. Moreover, the disruptive and transformative nature [35] of this technology is not at all guaranteed for food chains. As mentioned, blockchain tends to redeploy existing forms of power in the food chains.

If we adopt a techno-centric point of view, the architecture of blockchain is supposed to guarantee transparency, traceability and data security [35]. Nevertheless, when only one actor (or two actors maximum) is in charge of filling in the information manually in the blockchain, it is conceivable that transparency, traceability, and security are not guaranteed. Blockchain joins the characteristics of digital communication technologies in the sense that they have given rise to a surveillance that can centralize control, reinforce entrenched positions, and infringe on privacy [55]. This study shows that using blockchain for transparency can lead to entrenchment for agricultural producers. As transparency can bring about "new forms of closure, manipulation, control, and surveillance," [50] it is these characteristics that seem to prevail in the introduction of blockchain into agri-food industry.

While transparency is often evoked as a key to good governance [48,49], here, transparency does not reverse the governance in place in food chains. Considered as a democratic practice with a strong emancipatory potential [50], transparency via blockchain seems even antinomic to this idea. In the cases studied, blockchain gives meaning to the combination of openness and oversight of transparency [51]. Because transparency can become tyrannical when it contributes to the proliferation of auditing, evaluation, and assessment measures [52,53], the use of blockchain reinforces these characteristics. Because the objects to be governed must be visible [57], the use of blockchain fits into this framework of thought.

As visibility and disclosure devices not only "reveal" what is hidden but also manufacture objects of knowledge [47], this research shows that some actors learn more than others through the use of blockchain. In this sense, transparency is well and truly governed [47]. Therefore, it remains interesting to carefully examine projects that promote transparency [60]. Sometimes transparency is presented as synonymous with "making

information available" or synonymous with "accurate information" [4,67–69], but it would seem that we should move away from an a priori definition or consideration of transparency.

Blockchain does allow for some oversight [39], but it is not easy to rule on its success at "making transparent." Contrary to what has been widely argued in the literature [19,35,61–66], this study even tends to show that blockchain is not a transparent technology at all. It is very difficult to know, via the actors in the field of investigation, how this technology works in practice.

This study tends to confirm that blockchain is likely to have implications in terms of competitiveness for actors in the agricultural and industrial sectors [71]. On the other hand, as argued by some of the literature [72], the idea that it would be able to transform the global food system should certainly be qualified, as it ultimately brings little transformation on the sample of chains studied.

It has also been argued that blockchain facilitates information sharing between food chain actors [74]. Nevertheless, this study proves the opposite. Blockchain can be combined with strategies of information compartmentalization. These strategies are also sometimes desired by the "upstream" actors themselves. In fact, subjects remain active participants in establishing transparency [47,85]. When information transmissions occur between actors in a chain, the way in which they are carried out confirms that transparency does not remove existing power inequalities [55].

In fact, it does seem that cases of underutilization of blockchain's potential are emerging [76] in order to make the technology adequate to the old functioning of a given sector. The cases discussed tend to show that in the use of blockchain for transparency, it is the centralized nature of transparency [55] that tends to trump the decentralized nature of blockchain. For some uses, blockchain ends up taking on the characteristics of a true panopticon [79,80] and not that of a reverse panopticon [86] or a horizontal panopticon [87].

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Appendix A

Table A1. Results reading from the metaphor of the panopticon.

Codes Identified by de Moya & Pallud (2020) [81]	Coded Result from the Collected Material
Power	
Subjection	Unchanged information transmission practices for agricultural producers but initially had to provide photos and videos showcasing them. Producers are not aware that the information they transmit is entered by the slaughterhouse into a blockchain.
Discontinuity of power	NA

Table A1. *Cont.*

Codes Identified by de Moya & Pallud (2020) [81]	Coded Result from the Collected Material
Automatic functioning of power	The blockchain is part of a desire to rationalize the allocation of financial compensation for practices considered "agroecological".
Visibility and unverifiability of power	The retailer isolates certain information between the actors in the chain. The information never "returns" to the previous actor. The trader is responsible for entering the data into the blockchain from the information provided by the producers.
Anonymous surveillance	Producers are not aware that the information they transmit is entered by the slaughterhouse into a blockchain. The blockchain is being used as part of broader digitization projects being conducted by the cooperative. The blockchain would support the future collection of farm data. This data would aim to attest to "virtuous" farming practices and sell new services to farmers from the cooperative.
Dissymmetry	The retailer is responsible for entering information into the blockchain based on what each of the actors in the chain has reported to the retailer. The retailer isolates certain information between the actors in the chain. The information never "returns" to the previous actor. The trader receives all the information from its partners but they do not know the information provided by their peers and the trader does not provide information on his own production to its partners. The cooperative transmits all the information given by the agricultural producers to the technical provider, but the producers do not have access to the information of their peers or of the cooperative. The producers do not have access to the in-formation of the other actors in the chain (even if they can have most of the information if they scan the QR code of the packaging).
Control of action	The blockchain is part of a desire to rationalize the allocation of financial compensation for practices considered "agroecological". Highlighting of "agroecological" practices followed on a voluntary basis initially The blockchain is being used as part of broader digitization projects being conducted by the cooperative. The blockchain would support the future collection of farm data. This data would aim to attest to "virtuous" farming practices and sell new services to farmers from the cooperative.
Power of mind	NA
Knowledge	
Comparison	The trader receives all the information from its partners but they do not know the information provided by their peers and the trader does not provide information on his own production to its partners. The blockchain is being used as part of broader digitization projects being conducted by the cooperative. The blockchain would support the future collection of farm data. This data would aim to attest to "virtuous" farming practices and sell new services to farmers from the cooperative.
Knowledge superiority of the supervisor	The retailer is responsible for entering information into the blockchain based on what each of the actors in the chain has reported to the retailer. The retailer isolates certain information between the actors in the chain. The information never "returns" to the previous actor. The trader is responsible for entering the data into the blockchain from the information provided by the producers. The trader receives all the information from its partners but they do not know the information provided by their peers and the trader does not provide information on his own production to its partners. The technical provider is re-sponsible for entering the data into the blockchain The cooperative transmits all the information given by the agricultural producers to the technical provider, but the producers do not have access to the information of their peers or of the cooperative. The slaughterhouse is in charge of entering the information of the actors in the chain into the blockchain. The producers do not have access to the information of the other actors in the chain (even if they can have most of the information if they scan the QR code of the packaging).
Discovery of new knowledge	Data hosted in the USA. The technical provider is responsible for entering the data into the blockchain. The cooperative transmits all the information given by the agricultural producers to the technical provider, but the producers do not have access to the information of their peers or of the cooperative. Highlighting of practices considered "virtuous" by manufacturers but not labelled. The communication of well-selected information to consumers makes it possible to mask the "industrial" dimension.

Table A1. *Cont.*

Codes Identified by de Moya & Pallud (2020) [81]	Coded Result from the Collected Material
Teaching	The cooperative transmits all the information given by the agricultural producers to the technical provider, but the producers do not have access to the information of their peers or of the cooperative. The blockchain is being used as part of broader digitization projects being conducted by the cooperative. The blockchain would support the future collection of farm data. This data would aim to attest to "virtuous" farming practices and sell new services to farmers from the cooperative.
Identification	Unchanged information transmission practices for agricultural producers but initially had to provide photos and videos showcasing them.
Body	
Altered behavior	The blockchain is part of a desire to rationalize the allocation of financial compensation for practices considered "agroecological". Highlighting of "agroecological" practices followed on a voluntary basis initially.
Prevention	The blockchain is being used as part of broader digitization projects being conducted by the cooperative. The blockchain would support the future collection of farm data. This data would aim to attest to "virtuous" farming practices and sell new services to farmers from the co-operative.
Heterogeneity	The selection of producers participating in the project was based, among other things, on their possession of a smartphone to be able to transmit digitized data. All producers in the initial chain (before blockchain) participate in the project Only about 50 producers were select-ed to contribute to the project (about 200 producers had applied). Highlighting of "agroecological" practices followed on a voluntary basis initially.
Experimentation	The blockchain is being used as part of broader digitization projects being conducted by the cooperative. The blockchain would support the future collection of farm data. This data would aim to attest to "virtuous" farming practices and sell new services to farmers from the co-operative.
Objectification	Unchanged information transmission practices for agricultural producers but initially had to provide photos and videos showcasing them. Producers are not aware that the information they transmit is entered by the slaughterhouse into a blockchain.
Space	
Unlocked disciplines	NA
Confinement	The retailer isolates certain information between the actors in the chain. The information never "returns" to the previous actor. The trader receives all the information from its partners but they do not know the information provided by their peers and the trader does not provide information on his own production to its partners. The cooperative transmits all the information given by the agricultural producers to the technical provider, but the producers do not have access to the information of their peers or of the cooperative. The producers do not have access to the in-formation of the other actors in the chain (even if they can have most of the information if they scan the QR code of the packaging).

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