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# The use of blockchain technology in the food traceability system

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***Abstract***

*This paper aims to address the exploration of blockchain technology comprehensive and sequential applications in e-agriculture by discussing how the integration can (i) enhance both backward and forward linkages in agricultural value chains, (ii) provide benefits to value chain actors (consumers and producers), (iii) improve the performance of the innovative technologies. Integrating blockchain technology into the agri-food sector has become increasingly useful for traceability systems, guaranteeing transparency and trust in the trade process, protecting consumers' right to information, and guaranteeing food quality and safety. The coupling of this technology in e-agriculture can generate positive externalities, including shared benefits, improved coordination among value chain actors, and real-time decision-making for optimal resource allocation and sustainable utilization in the context of e-agriculture. To enhance clarity, the paper examines a use case related to agricultural inputs, commodities, and products in the cereals sector to illustrate the application of data collection devices and the role of blockchain technology in data validation, storage, security, and transmission. However, blockchain applications have faced several limitations in practice, so many legal questions related to the actual success of the interaction are still open. To make just a few examples, the more relevant legal issues are related to data validation, storage, cyber security, and privacy. It is not easy to organically and comprehensively represent every critical and problematic aspect. However, this contribution will attempt to review, albeit briefly, the most relevant legal issues arising from the interaction.*

***Keywords****: Digital transition, Blockchain technology, Agri-food supply chain, Traceability, Food quality and food safety, Producers, Consumers, Wheat supply chain.*

## 1. The digital transformation of the agri-food system

The phenomenon of digitalization is part of the completion of the long process of globalization that has hit our planet in recent decades, and which has found its realization through the new immaterial and delocalized dimension, without borders, generated by digital commercial platforms conveyed through electronic communication networks.

In the context of an increasing functionality of technologies, which have affected both the market economy and social life, the agri-food sector has also been affected by technological innovation.

In the process of learning and knowledge of the interaction between innovative technologies and the agri-food sector, we should first consider an overview of the role attributed to the digitalization of food traceability in the geographical scope presented by European and internal legislation.

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The core of the latest European Union Policies corresponds to the need to achieve the UN Sustainable Development Goals (SDGs), which thrived from the urgent action required to address biodiversity loss, and the related triggering causes (food waste and losses, pollution) of global health threats such as climate change and worldwide hunger, with a systematic sustainable approach.

Thus, in 2019, the recently established European Commission communicated its renewed commitment to fight climate change and environmental degradation by introducing the European Green Deal (EU Green Deal) for the European Union and its citizens. The EU Green Deal is part of the EU's overall strategy to achieve the UN SDGs, providing a roadmap of policies and measures.

The Communication indicates needed policies and measures to contribute to the EU Green Deal, among which the crosscutting key element is digitalization, intended as the "socio-technical process of applying digital innovations".

Digital innovations include Internet of Things (IoT), Artificial intelligence (AI), Machine learning, Blockchains, Digital twins, and other technologies utilized through digital tools, contributing to the creation of cyber-physical systems and producing both positive and negative impacts at the socio and economic level.

We can highlight that within the EU institutions, the phenomenon has been studied and deepened in the European Digital Agenda for the decade 2020-2030 specifically dedicated to these issues. The Digital Agenda also deals with the creation of secure digital spaces and services, but also a level playing field in digital markets with large platforms, and also aims to reduce the technological lag between the United States of America and China, as there is a strong awareness that it cannot fully express Europe's potential in terms of digital leadership.

As a direct consequence of digitalization, there has been a real need for states to regulate the use and management of data.

How a State regulates and exercises the governance of technology and services used in various ways within the national perimeter is defined as "Digital Sovereignty".

This means managing and ensuring the protection of sensitive data, allowing companies, organizations, and individuals to take advantage of all the opportunities related to the digitization of information while maintaining control of where data resides, where it flows, and who has control over it. When it comes to digital sovereignty, therefore, the social and regulatory implications are broad and diverse.

In this direction, a further objective pursued by the European Union (hereinafter also "EU"), is to raise the level of attention to cybersecurity and control and determine the implementation of data with technology.

It is precisely the spread of digitalization in so many fields and economic sectors, and the consequent phenomenon of digital sovereignty, that has placed sociologists, economists, and jurists – albeit in different ways – in front of a dilemma if technology could be put at the service of all economic and social sectors.

The food sector is pursuing the challenge of incorporating the use of technological tools into production chains. It can be innovated through digital services and systems that make it possible to preserve the environment, increasing the productive capacity of the land but at the same time reducing the use of those resources and parts that then have difficulty regenerating.

The technological development and the spread of digitalization have fostered the evolution of an integrated and increasingly evolved agricultural management model, whose applications can be considered tools for the traceability system and allow the most appropriate decisions to be made in terms of sustainability, efficiency, and respect for the territory.

Of course, the use of technologies in the agri-food sector involves a wide range of legal areas that require the attention of the legislator of the individual Member States as well as the European Union. For example, the use of drones, GPS, driverless driving and worker safety, civil liability, legislation on water, nitrates, plant protection, animal welfare, soil degradation, environmental exploitation, and measures to incentivize agricultural activities, but above all the protection of data transfers.

This leads to a new vision of the agricultural supply chain according to which, thanks to the

implementation of digital technologies in all the individual segments of the supply chain, the entire sector can support resilient and sustainable models, to respect the environment more and – last but not least – to increase its competitiveness on the market. Going back to what was explained at the beginning, about the active role of the bodies of the European Union, also in this area, the European Commission is the bearer of the needs felt at the Community level, and has pursued in recent years numerous projects and actions aimed at this purpose.

On the one hand, digitalization promises an increase in the effectiveness and efficiency of value chains and production processes (e.g. Smart agriculture), a greater ability to adapt and forecast (e.g. Big data and business intelligence), and interaction with end consumers (web technologies and market intelligence).

By improving processes across the entire supply chain and leveraging the data generated in each area of the value chain, digital promises to reduce the industry's carbon footprint. On the other hand, the "green" transition appears urgent for at least three reasons: the non-postponement of the reduction of the effects of human activities on the climate, including those related to agriculture and the processing of its products; consumers' growing attention to the environmental and social sustainability of the companies they turn to meet their needs; the strong orientation of the financial system (public and private) to combine accessibility and sustainability, considering the most advanced company profiles in ESG criteria as less risky.

## 2. Blockchain technology to foster transparency, traceability, and trust

In this context, the question arises as to whether and how technologies can make a positive contribution to the achievement of the objectives of sustainability and protection of the right to food.

The role of digital technologies is primary because technologies become enablers of a new agri-food model, oriented towards the use of data, the collaboration of the players in the supply chain, and the attention and centrality of the end consumer.

The topic of digital transition in the agri-food sector mainly involves digital tools that have been developed in other sectors, such as finance. Among the innovative technological systems, those that seem most adaptable to the agri-food reality are distributed ledgers, and in particular blockchain technology, which makes concepts such as disintermediation and decentralization its essence, and that seem to be able to offer satisfactory answers to the transformation needs of sustainable food systems (Von Braun *et al*., 2023).

Due to its characteristics, the blockchain can represent a system for storing and exchanging data - referring to a product, including food - to prevent counterfeiting, fraud and food waste, and at the same time guarantee the consumer the certainty of the origin of that product as well as information on its organoleptic characteristics (Winkler *et al*., 2022).

As is well known, blockchain technology, or rather applications that use the blockchain protocol, has become increasingly widespread over the past few years. The world of finance, cryptocurrencies, and Bitcoin is still the hegemonic application sector.

Blockchain is part of Distributed Ledger Technology (DLT). It is based on the so-called chain of custody and guarantees complete traceability (present and past) of the actions and behaviors of the different operators in a network of exchanges and relationships. The term blockchain derives from the union of the words block and chain. It is a decentralized distributed database structured as a chain of blocks containing transactions that are related to each other according to a chronological principle and whose integrity is ensured by a system of algorithms and cryptographic rules.

Blockchain technology in the agri-food sector holds significant promise for managing global production, marketing, and consumption chains of agri-food products, as well as for developing and consolidating knowledge and skills (Sirsi, 2022; Fu Li, 2019; Remotti, 2021). On a blockchain platform, each participant in the supply chain can record traceability information related to their operations, ensuring it is immutable and visible to all other nodes in the network.

Consumer information is a fundamental part of the agri-food legislation, especially about the

Community origin, which over time has been enriched by an elaborate system of rules aimed not only at protecting the health of the consumer, but also at certifying the product in such a way as to allow the consumer to direct his choices towards products with certain characteristics, concerning, for example, origin or environmental sustainability. In the examination of the applications of blockchain technology to the agri-food sector, two profiles emerge that arouse interest and deserve to be analyzed in more depth: its objectives and the main fields of use.

The main objectives of blockchain technology applied to the agri-food sector range from promoting sustainability to protecting and guaranteeing food safety and consumer health. It is about ensuring sustainable food production and food security, promoting a sustainable food supply chain from start to finish: from processing to sale (both wholesale and retail), and also ancillary services, such as hospitality and catering, promoting sustainable food consumption and supporting the transition to healthy eating habits, fighting food fraud along the supply chain and reducing waste grocery.

As far as the main fields of use are concerned, it is worth mentioning the possibility of archiving and making immutable the certification processes of a product.

This is done through a platform that makes it possible to collect data, make it immutable and at the same time available to certifiers and consumers, who would thus have the opportunity to know the entire path taken by the product along the supply chain.

At the national level, the research carried out by the CREA research center and the Blockchain Observatory of the Politecnico di Milano, a center of excellence in Italy, is also moving in this direction.

The analysis of the data collected in the last two years has verified that the projects applying blockchain to traceability and certifications have made it possible to monitor compliance with quality standards in the fishing sector to guarantee nature reserves but also to verify the presence of allergens and the withdrawal of compromised batches with a view to food safety.

To implement the control and conservation measures of the path taken by the food product, the use of blockchain is of particular importance, for example in the event of the emergence of a danger to human or animal health, in the case of activation of the rapid alert system developed within the European Union (RASFF). In this case, risk communication to the consumer plays a central role to limit potential and actual adverse effects on human and animal health and welfare, and at the same time limiting the permanence of dangerous products on the market. In essence, the relationship between science and law, consumer awareness, and the strengthening of the relationship with the producer also passes through the application of innovative systems suitable for promoting greater awareness during the intake of food products through knowledge of the life cycle and chemical composition of the product, empirical and tangible not only entrusted to mere probabilistic evaluations.

In this context, trust, traceability, and transparency became critical factors in designing circular blockchain platforms in supply chains.

The bridge from the three circular supply chain reverse processes (i.e., recycle, redistribute, remanufacture) and the three factors (i.e., trust, traceability, transparency) the blockchain platforms in a supply chain, including manufacturer, reverse logistics service provider, selection center, recycling center, and landfill, could be the answer.

The results highlight blockchain's role as a technological capability for improving control in the movement of wastes and product return management activities.

For real transparency in the agri-food sector, the communication tool par excellence is the label and labeling, so it too, like traceability, represents a territory of choice for the application of blockchain technology. Consumers increasingly require a range of nutritional information and, concerning this right to information, blockchain seems to offer the best answer, since it is a tool that promotes the knowability of information related to traceability. With the introduction of the mandatory nutrition declaration on the label, it has been possible to respond to the emerging needs for greater transparency for health prevention, greater identifiability of data relating to the

nutritional aspects of the product and greater environmental sustainability.

Manufacturers are obliged to report all the information regarding: the identity, composition, properties and other characteristics of the food, shelf life, methods of use and harmful effects.

To quickly convey information, the so-called smart labels have also been introduced, capable of automatically identifying and tracking goods by detecting alterations or health risks, related to alterations in the correct storage temperature or contamination of the environment, and reporting optional information but with increasing value since it contains information relating to the life cycle of the product in light of the choices made within the of the European Union to create an environmentally-friendly, resilient and sustainable system.

Blockchain can make a positive contribution to verifying the veracity of labels, in particular, smart *labels* (characterized by barcodes or QR codes or equipped with more sophisticated systems such as RFDI or NFC tags).

The spread of smart labels as a useful tool for greater transparency and communication of information has made it possible to strengthen the relationship between operator and consumer. On the other hand, it has proved to be particularly useful in ensuring greater traceability of the agri-food product throughout the supply chain, combating counterfeiting phenomena, and promoting the conveyance of information relating to ethical choices.

However, the scope in which the blockchain can make several improvements to the food sector is the traceability system.

Traceability has been defined by Regulation (EC) No 178/2002 (Prete, 2024).

In fact, among the many definitions found in legal literature, in the aforementioned Regulation in Article 3, paragraph 15, there is the definition of traceability as "the possibility of reconstructing and following the path of a food, feed, animal or substance intended or likely to become part of a food or feed through all stages of production, Transformation and Distribution".

Article 18 of Regulation (EC) No. 178/2002 then deepens the definition in terms of objective and expected results and establishes the obligation for all operators in the sector to provide information on the origin of products and all the subjects involved in the individual stages of production along the entire supply chain. Article 18(2) and (3) provide: "2. Food and feed business operators must be able to identify who has supplied them with food, feed, food-producing animals or any substance intended for or likely to be incorporated into a food or feed. To that end, those operators must have systems and procedures in place to provide information to competent authorities upon request".

In summary, the agri-food system outlined by Regulation (EC) No. 178/2002 – which still represents the reference legislation for the traceability institution – highlights that traceability does not make a product safe in itself, but represents a means of limiting a real food safety problem.

The institution of food traceability has been the subject of intervention of the new Common Agricultural Policy adopted by the European Council for the period 2023 – 2027, for a more sustainable system. This includes Regulation (EU) 2021/2115 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy ('CAP Strategic Plans') and financed by the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD), as well as the repeal of Regulations (EU) No 1305/2013 and (EU) No 1307/2013. Article 47(1) of the Regulation provides that for each objective of the CAP Strategic Plans, Member States may choose a type of intervention, including "the implementation of traceability and certification systems, in particular with regard to the quality control of products sold to final consumers".

Article 84 of the Regulation, on the other hand, provides for a specific delegation of powers to the European Commission to establish additional requirements regarding the types of rural development interventions, including support for traceability. Finally, Article 100 of the Regulation empowers the European Commission to assess the contribution of policy to the achievement of climate change objectives through a simple and common methodology: the traceability of climate-related spending.

Traceability has also been a strategic objective of the main international organizations and associations carrying out activities in the agri-food sector. Thanks to the ISO ("International Standardization Organisation") standard UNI EN 22005:2008, the main actors involved in the agri-food supply chain system – such as the Codex Alimentarius Commission, the International Association of Hotels and Restaurants, the Global Food Safety Initiative (GFSI) and the Confederation of Agri-Food Industries of the European Union (CIAA). It is able to identify and track every aspect of the activity of the operators involved in the process, from the farm to the consumer's table. In such a structured context, in which transparency and knowability of the phases of the food production process constitute the *vulnerability* of the agri-food sector, it is physiological that operators are looking for tools capable of making this process fast, simple, functional, effective, and efficient; but, above all, tools that are able to contain, store and manage a huge amount of information related to the entire food supply chain.

Traceability allows the product to be identified with regard to details related to weight, allergens, type of packaging, specifications, expiration dates and dates of manufacture which are all recorded and transferred together with the product to facilitate identification.

The same benefits can also be found on the consumer side. In fact, knowing the path taken by the product (from its birth to the marketing of the finished product) allows consumers to keep track of the time, the conditions of conservation and storage, the controls carried out and the path taken by the product along the supply chain throughout the supply chain throughout the supply chain life cycle, so that you can guide your choices in a conscious way.

Ultimately, blockchain technology would act as a tool that makes it possible to ensure the effectiveness of the right, meaning the quality of the latter to produce effects that conform to the interests of consumers concerning the reality that exists today. In this scenario, the blockchain – by its advantageous properties – allows precision monitoring and a means of incentivizing and encouraging virtuous behavior and denouncing and sanctioning illegitimate behavior. It is also able to create a transparent traceability and communication system aimed at combating civil and criminal offenses.

By leveraging the characteristic of disintermediation, or decentralization of control, the sharing, reuse, and recycling of materials are encouraged, therefore environmental sustainability and the circular economy are favored in a related way so as to facilitate industrial symbiosis with the establishment of a promoted communication and certification system.

## 3. The case study of the wheat sector

The wheat supply chain belongs to the cereals, referred to as herbaceous plants belonging to the botanical family of grasses.

For a company that has already established contracts with farmers for the raw material, this involves aligning the batches of wheat production, with the batches of semolina production, and the batches of pasta.

It allows for the certification of the entire supply chain, starting from the finished pasta product and going back to the wheat field where the raw material was grown.

Then, the wheat supply chain belongs to the cereals, referred to as herbaceous plants belonging to the botanical family of grasses. In the big family of cereals, we can find: grain and wheat (which are equivalent), and other raw materials, commonly used to make pasta, bread, and cookies, as wheat or corn, corn or maize, barley, rice, spelled, rye, oats, millet. Among gluten-free cereals, we find buckwheat, amaranth, quinoa and chia.

Over the years, the European Union has developed a composite toolbox of rules to give definitions of these products and to guarantee the traceability of raw wheat, rice, and dairy products at agricultural sites.

As it is known, the supply chain traceability rules are divided into mandatory (horizontal and vertical) and voluntary. In detail, the horizontal regulations are applied to all supply chain traceability while the vertical ones refer to the traceability of specific products traceability is addressed by specific vertical regulations at the European (EU) and national levels.

The company is Pastificio dei Campi.

Pastificio Dei Campi is an Italian company known for crafting high-quality pasta with a strong commitment to tradition and product excellence. Founded in 2004 by Giuseppe Di Martino and his wife Giovanna Di Martino, who are partners in the historic Di Martino pasta factory (1912) located in Gragnano, in the province of Naples, Italy. The Di Martino Group also includes other renowned Italian brands like "Grandi Pastai Italiani" and "Pastificio Antonio Amato".

The primary goal of Pastificio dei Campi is to preserve and enhance the tradition of Italian pasta production while ensuring the utmost quality in their products.

For Pastificio dei Campi, the traceability of the supply chain means the ability to track and certify the entire journey of the product, from its origin in the fields to the consumer's plate. Traceability, therefore, serves as a tool that can assist the producer in certifying the quality of the final product. Regarding quality, there are three key stages in the pasta supply chain:

- The production process (wheat production),
- The mill that processes the wheat into semolina,
- The pasta factory that produces and packages the pasta.

In the case of Pastificio dei Campi, the traceability system, understood as the ability to trace and track all product movements throughout the entire supply chain, represents a kind of reinforced certification of the chain. This is because it enhances transparency and provides greater quality control, both internally within the company and externally, in the management of all subcontractors.

Traceability is an integral part of the company's business model, serving as a competitive and mostly voluntary tool to establish an advantage through product differentiation (high quality pasta vs the standard industrial pasta). Its inception is driven by a market-oriented goal, namely, to facilitate the creation and promotion of pasta with a fully Italian supply chain (100% Made in Italy), generating trust in the consumer and facilitating the purchasing process.

Above all, it offers more information about the authenticity and safety of the product to the end consumer compared to standards related to the origin.

Traceability, thus, acts as a competitive advantage for corporate differentiation strategies centered around Gragnano's pasta-making tradition, its favorable terroir, and the quality of the Made in Italy product.

In these terms, traceability is integrated into the company's mission and becomes a value through which management develops its actions and marketing narratives.

The most innovative aspect of the traceability system implemented by the pasta factory is undoubtedly the development of external traceability.

This external traceability encompasses the agricultural companies with which supply chain contracts have been established, as well as the mill responsible for wheat processing. It caters to the need for increased transparency and control in these phases.

For the farmers, or more specifically, the technical staff like agronomists and consultants, they input the wheat harvesting date and the quantity of wheat batches delivered to the mill (i.e., the transport document certifying the transaction) into Authentico's blockchain. Additional information related to the transaction, such as the field log, the documentation on the varieties, the location of the fields via GPS, and all other product certifications (e.g., organic), can be added.

The mill, on the other hand, adds another block of information indicating the quantity of wheat stored based on orders received from the pasta factory. Consequently, it is possible to trace the amounts of wheat processed to produce semolina and the respective processing date. These details are supplemented with any technical specifications and analyses of key parameters (humidity, etc.).

Internal traceability involves the pasta factory with its two departments, namely the pasta production and packaging departments in Gragnano. In detail, the warehouse records in the blockchain the quantities of semolina loaded into the warehouse and the quantity of semolina processed. Additionally, the packaging department enters into the blockchain the amount of pasta produced and the packaging date of the respective batch of pasta.

Blockchain supports the digital certification process of product and raw material traceability, addressing the agri-food sector's growing demand in Italy. The traceability trend over Blocklchain is driven by the necessity to safeguard Italian excellence from fraud and the heightened awareness of consumers. Blockchain's advantages include data inviolability, tamper resistance, data security, and immutability, making it especially valuable for companies like Pastificio Dei Campi, which aim to transparently share transaction results throughout the supply chain.

This approach guarantees certainty regarding the handling of raw materials and processed products.

Since its inception, the company has chosen to improve the transparency of its processes and at the same time increase control over external operations. However, at the beginning, in 2004, the costs and available blockchain solutions were far from competitive and affordable. The costs were prohibitive.

The company had to wait several years before finally discovering a tailor-made solution in Authentico that aligned perfectly with its needs.

With Authentico, they improved corporate transparency and digitised its supply chain by leveraging blockchain technology developed by Quadrans. The technology developed by Quadrans, first of all, had a cost (especially in terms of energy) that was extremely competitive in the market and, most importantly, it did not rely on cryptocurrencies, significantly reducing the cost for the company.

The presence of affordable costs and mature technologies allowed all participants in the Pastificio Dei Campi supply chain to access the same platform, a crucial requirement for the digitisation process. The primary fixed cost (setup) is distributed between the pasta factory and the mill, the main actors in the supply chain. Subsequently, each participant, including farmers, incurs a fixed fee comparable to other certification costs, along with a variable fee in the form of a monthly subscription invoiced semi-annually or annually. This variable fee is determined by the number of batches uploaded. The platform offers a tiered pricing structure with five levels, starting with the smallest level for micro-enterprises producing up to 50 batches of products per year.

Authentico goes beyond a voluntary digital registry. It provides a cloud platform that facilitates mandatory traceability for food companies, offering several advantages, such as reducing response times for non-compliance issues, controlling over production efficiency, processing, monitoring and quality control.

Blockchain supports the digital certification process of product and raw material traceability, addressing the agri-food sector's growing demand in Italy. The traceability trend over blockchain is driven by the necessity to safeguard Italian excellence from fraud and the heightened awareness of consumers. Blockchain's advantages include data inviolability, tamper resistance, data security, and immutability, making it especially valuable for companies like Pastificio dei Campi, where they can finally transparently share transaction results throughout the supply chain.

Ultimately, the main challenge sometimes lies in uniting the entire supply chain within a system like the one developed by Pastificio dei Campi, where alignment between all actors is crucial. The desire to trace raw materials can become an obstacle, which may be more cultural in nature. The key element, perhaps the most significant obstacle, is that it is not within everyone's reach. Achieving transparency for companies today is essentially a challenge, as not everyone is inclined to do so.

To date, the resistance encountered in adopting this technology is the commitment of companies to embrace true transparency. Technology can only really provide added value and market recognition for those companies that prioritize trust and transparency as core values.

## 4. Conclusion

Regarding the use of technology, many doubts are still fighting against the favorable prospects for the planet in the name of a more sustainable supply chain.

At the end of the digression made, it seems fair to infer that blockchain traceability can foster several elements, as the immutability and

non-alteration of the product and to avoid food fraud, the certification of product quality, the capacity to give choice of consumption about quality, the composition of the product, and the route taken from raw material to sale, and the risk mitigation related to food safety and food security.

However, when it deals with technologies, the implications and critical aspects concern at least three factors: human factor, environment, cyber security, data acquisition and management.

Digital technologies have an undeniable environmental impact.

Of course, the effects of digital technologies on the environment are certainly less severe than those caused by larger sectors such as transport and industry.

However, recent developments aimed at making the ICT sector increasingly efficient do not guarantee that its emissions will remain relatively low in the future.

Among the side effects of this process, we can find the ongoing climate and environmental change on our planet caused mainly by the increase in the concentration of carbon dioxide in the air and the dispersion of plastic in the oceans and seas.

By its conformation, the system involves interaction between individuals, humans and digital tools, so ad hoc procedures are needed to ensure that all actors have the appropriate skills to avoid errors in the process.

It is not just a matter of technological, regulatory or organizational barriers capable of evolving, over time, to keep pace with progress. But it is about being able to understand, on the one hand, how blockchain can be adapted to the complexities of the food sector and, on the other hand, whether it is possible to incorporate it into the relationship of trust between producer and the final consumer.

In order to achieve a functional and stable system, it is necessary to create a defense and security structure against cyber attacks resulting in data loss and theft. In addition, it is necessary to identify who is in charge of such control to avoid data control being managed outside the Union, to the detriment of European agriculture as a whole.

Making supply chain data immutable and transparent is a risk, in the absence of adequate data validation tools and the absence of a truly controlled and reliable supply chain.

It must be remembered that the fact that information entered into the blockchain is shared and immutable does not imply any guarantee that it is true, since the very nature of the blockchain rests on self-certification. It is therefore imperative to emphasise that, however innovative and effective it may be, this tool is not in itself sufficient to guarantee the actual origin of the products that are the subject of it, nor should it be understood as a means to replace traditional controls and activities carried out by third parties.

To prevent the adoption of a tool for innovation and competitiveness from becoming a boomerang for the company, effective teamwork is required between platform providers, IT programmers, the company's production units, suppliers and professionals working alongside the company as lawyer, accountant, food technologist, agronomist, marketing experts.

## References


Ching Fu L., 2019. Blockchainizing Food Law. *Food and drug law journal*, 4/74: 586-612.

Cordis, 2024. *La rivoluzione tecnologica dell'identificazione a radiofrequenza (RFID)*, https://cordis.europa.eu/article/id/27095-the-rfid-technological-revolution/it.

*Decision (CE) No. 96/88/EC, concerning the approval by the European Community of the Grains Trade Convention and the Food Aid Convention, constituting the International Grains Agreement 1995*.

*Decision (EU) No. 178 of 2021 concerns the position to be taken on behalf of the European Union in the International Grains Council on the amendment of the definition of a cereal or grain within the Grains Trade Convention 1995*.

*Decreto del Presidente della Repubblica 9 febbraio 2001, n. 187, Regolamento per la revisione della normativa sulla produzione e commercializzazione di sfarinati e paste alimentari, a norma dell'articolo 50 della legge 22 febbraio 1994, n. 146*.

*Delegated Regulation (EU) No 2016/1238 - Implementing Regulation (EU) 2016/1240 - List of cereal stores - List of rice stores*.

European Commission, 2024. *Il Green Deal europeo*, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_it.

Ferrari M., 2024. Le imprese alimentari e la digitalizzazione. In: Borghi P., Canfora I., Di Lauro A., Russo L. (eds), *Trattato di diritto alimentare italiano e dell'Unione Europea*, II ed. Milano: Giuffrè, pp. 277-288.

Gallo P., 2022. L'applicazione del sistema blockchain e degli smart contract per la tracciabilità e il controllo della filiera vitivinicola sostenibile: esperienze criticità e prospettive di sviluppo. In: Pisciotta Tosini G. (ed.), *Comunicazione di sostenibilità e blockchain: strumenti giuridici e prospettive tecnologiche per il settore vitivinicolo*. Palermo: Palermo University Press.

Gallo P., Daidone F., Sgroi F., Avvantaggiato M., 2021. *AgriChain: Blockchain Syntactic and Semantic Validation for Reducing Information Asymmetry in Agri-Food*, CEUR Workshop Proceedings, CEUR, pp. 103-118.

Germanò A., 2003. Commento all'art. 3, La sicurezza alimentare nell'Unione europea, Commentario al regolamento CE n. 178/2002, AIDAC. In: *Le nuove leggi civ. comm*., 167.

Ghiani A., 2021. *Blockchain: line guida. Dai casi pratici alla regolamentazione*. Torino: Giappichelli Editore.

La Porta B., 2023. *Contributo per una visione contemporanea dell'azienda agricola*. Torino: Giappichelli Editore.

Lyons T., Courcelas L., 2019. *Blockchain in trade finance and supply chain*. European Union Blockchain Observatory and Forum, 9-2019.

*Paris Agreement, adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12 December 2015 and entered into force on 4 November 2016*.

Prete F., 2024. La tracciabilità. In: *Trattato di diritto alimentare italiano e dell'Unione europea*. Milano: Giuffrè, pp. 353-360.

Regulation (EU) No. 1169/2011, of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004 Text with EEA relevance.

Regulation (EU) No. 1308/2013 establishing a common organisation of the markets in agricultural products, and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007.

Regulation (EU) No. 1370/2013 determining measures on fixing certain aids and refunds related to the common organisation of the markets in agricultural products, cereals and rice.

Regulation (EU) 2023/988 of the European Parliament and of the Council of 10 May 2023 on general product safety, amending Regulation (EU) No 1025/2012 of the European Parliament and of the Council and Directive (EU) 2020/1828 of the European Parliament and the Council, and repealing Directive 2001/95/EC of the European Parliament and of the Council and Council Directive 87/357/EEC (1).

Remotti G., 2021. Possibili funzioni ausiliarie delle tecnologie blockchain per marchi e indicazioni di origine: tracciabilità della filiera agroalimentare, dinamica competitiva e meccanica mercantile. *Alimenta*, 3: 29-52.

Remotti G., 2022. Blockchain technologies per la filiera agroalimentare. *Alimenta*, 6: 473-513.

Sciaudone G., 2024. I soggetti dell'attività produttiva: le imprese alimentari e gli operatori del settore alimentare. In: *Trattato di diritto alimentare italiano e dell'Unione europea*. Milano: Giuffrè, pp. 337-344.

Sirsi E., 2022. L'impiego di blockchain nell'agroalimentare: introduzione alla giornata di studio. In: Navarretta E., Ricci L., Vallini A. (eds), *Il potere della tecnica e la funzione del diritto: un'analisi interdisciplinare di blockchain*. Torino: Giappichelli, vol. II, pp. 217-221.

Szewczyk P., 2019. Application of blockchain technology in supply chain management. *Scientific papers of Silesian University of Technology*, 136: 591-600.

Von Braun J., Afsana K., Fresco L.O., Hag Ali Hassan M., 2023. *Science and Innovations for Food Systems Transformation*. Cham: Springer International Publishing, 948 pp.

Winkler H. (ed.), 2022. *Blockchain-Based Digitalization of Logistics Processes Innovation, Applications, Best Practices*. Basel: MDPI.