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Laura Roma
Università degli Studi di Napoli Parthenope, laura.roma001@studenti.uniparthenope.it

Rocco Agrifoglio
"Parthenope" University of Naples, rocco.agrifoglio@uniparthenope.it

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Understanding the use of emerging technologies in the agrifood industry: a case study

Laura Roma and Rocco Agrifoglio

University of Naples 'Parthenope', Via Generale Parisi, 80132 Naples, Italy

Abstract. The research aim is to understand how emerging technologies, and in particular the blockchain, affect business organization in the agrifood industry. In particular, it explores how decentration, distribution and digitalization ledged could be integrated in the precision agriculture in order to allow organizations to share information with stakeholder, to improve relationship with customers, and to develop a network with other firms.
After, reviewing the IS literature on emerging technologies in agri-food industry, with peculiar reference to the blockchain technology for precision agriculture, it is analyzed the case of BioLu, a small innovative Italian farm located in Campania Region. Our results shown how emerging technologies support precision agriculture through data collection and exploitation for entrepreneur (e.g., decision-making) and consumers (e.g., food traceability), rather than agrifood supply chain.

Keywords: Blockchain, emerging technologies, agrifood, BioLu.

1 Introduction

One the most important sector is agrifood, without doubles, in the economic and social terms. Moreover, agrifood economic area is very complex due to (i) huge biodiversity of goods offered, which have different issues to manage; (ii) short-time-deterioration of fresh products require careful process to safeguard product; (iii) weather conditions or diseases and pests have a great impacts on production income; (iv) transport cost is unavoidable in global market, in which are clients in the whole world; (v) heterogeneous needs of costumers influenced by gender, age, sexual and political orientation, ethnicity and cultural backgrounds.

Anyway, agrifood sector is distinguished by common issues such as (i) food supply chain safety to avoid toxic agents spread and to protect public health; (ii) guarantee of products quality to be safeguarded by counterfeiting; (iii) efficient management of scarcity resources to ensure goods of first necessity while worldwide population grows. Therefore, it is necessary to have information to track poisonous products soon it is possible, to recognize high quality goods from their imitation and to understand how company can reduce wastefulness of resources. In this case becoming essential to have instrument, which record data and collect them to elaborate information, crucial to make business decisions.

The first step through technological world is began with sensor, capable to reveal every single data. Then the next step is possible thank to earthbound cable-based and

wireless radio-based, which are able to create communication networks such as Wide area network (WANs), local area networks (LANs), wireless local area networks (WLAN) and the Global System for Mobile Communication (GSM) up to satellite-based communication nowadays. As a matter of fact, communication networks support the development of smart sensors, which are able to transfer recorded data to recipients. In such a way, it is possible to define these types of instruments as Internet of Things (IoT), which companies use to (i) have interactive communication with network receiving and sending information; (ii) communicate with other digital device; (iii) scan and to identify objects and locations. Although wireless sensors networks improve data quality recording, huge amount of data have to be management and so it necessary to identify efficient and efficacy data mining methods such as data systems, artificial intelligence, machine learning.

It is important to consider limit of data collected through ICT technology devices, for example IoT, which use centralized system to store data [1]. Furthermore, centralized system's limitations can be overcome with the blockchain. Distributed and decentralized technology guarantees data's reliability since they are collected with advanced technology devices [2]. Using ICT devis with blockchain technology cover corrupted data's risks due to a centralized system and manual data entry errors.

Here starting to look for how collected data can improve business organization to make efficient and efficacy decision also in unexpected issues show up during the productive routine. It is necessary to underline how information elaborated by collected data can be also used to improve trust relationship with customers and to implement business network with upstream and downstream companies through affordable communication. In this case blockchain ensures to have affordable track thank to unchangeability of data recorded and verifiability of supply chain.

The aim of the paper is to understand how emerging technologies, and in particular the blockchain, affect business organization in the agrifood industry. In what follow, it is described the enabling technologies in the agri-food industry (Par. 2), the role of blockchain technology for precision agriculture (Par. 3), and the research method (Par 4.), with peculiar reference to the case of BioLu, and report the research discussion and conclusions (Par. 5).

2 Enabling technologies in the agri-food industry

At the beginning it is crucial to understand the implementation of ICT in agriculture is influenced by socio-demographic factors affecting age, education level, innovativeness, income and wealth levels, degree of risk perception, and knowledge. In-deed, younger farmers have greater propensity to adopt ICT than in older entrepreneurs, who are reluctant to change [3]. Further-more farmers, who have higher education level, are more prone to adopt new technologies [3,4]. Sure enough, big companies, which have economic stability and financial resources, are more likely to risk and bet on ICT innovation [5]. Other aspect is internet access, determinate on the company's geographic location, makes easy to adopt smart technologies. When companies recognizing ICT tools usefulness, it is facilitating propensity to adopt technologies. It is becoming

essential to have discussion groups, which share user feedback and increase knowledge, so exchange of opinions can promote the adoption of ICT tools. [6].There aspects are cause of difficulties to promote techno-logical change in agricultural environmental due to high presence of men with a low level of education and be composed by small and medium enterprises. It is relevant to analyze environmental composition to find the way thought make possible technological improvement.

Nowadays companies record data through satellite technology, GPS tracking, drones, wireless device and radio-frequency identification (RFID), these technologies are examples of Information and communications technology (ICT) which is employed in various fields, including agriculture.

Indeed e-agriculture was born to monitor production processes with modern technologies such as ICT. In traditional agriculture, the preparation of the soil for sowing or irrigation for the spread of fertilizers and pesticides, is performed indistinctly on the entire cultivated area. Instead, precision agriculture is developed by means of technological devices capable of capturing different parameters from soil characteristics, climatic conditions or water tracking in order to facilitate decision-making [7].

Remote Sensing (RS) technologies monitor crop growth, moisture conditions and water consumption, allowing farmers to supply water to crops in the right location, at the right time and in adequate quantities, in response to expected water stress and likely delays in harvesting [8].

One the first auto-identification and data capture (AIDC) technology is radio-frequency identification (RFID), which can recognize goods and locations positioned through a transponder (tag). Furthermore, RFID system works through wireless connection with transceivers, which are able to read data collected into tag. In agricultural environment RFID installed on a leaf to detect temperature and report the water stress level of plant to calculate the optimal irrigation [9].

In precision agriculture, the development of smart drones deals with irrigation monitoring, weed identification, crop monitoring, pesticide spraying, as well as deterrence of fertility levels, identification of bacteria, fungi or diseases based on common infrared radiation reflected by sensors or thermal images [10].Within this field, deep learning has recently been adopted [11] which allows the recognition of weeds.

Deep learning is used for harvesting fruit based on infrared devices and the ripening color of the fruit [12], such as mango and apples. Thanks to the advancement of the technology, the monitoring of agricultural activity can be followed at any time and remotely through the smartphone application [13]. At first, technological devices were used to detect agricultural data. Now, the same devices are becoming technological intelligences that can be operated remotely from the smartphone.

One of the main reasons leading farmers to use such technologies is to achieve higher production efficiency. Indeed, with the same inputs, we could have a greater production because, for example, the nutrients present in the soil favor the flourishing of the crop. The lack of rain has a big impact on agriculture and for this reason, to save the crop, additional costs for irrigation have to be paid. It is possible to estimate the need for water [14] with visible and near-infrared spectrums to detect live vegetation, thus providing the resource in a targeted manner and preventing the plant from perishing due to the lack of water. Rainwater is also exploited to feed the crop, thus saving

resources to be used in irrigation operations [15]. The FieldLook platform provides information on rainfall water flow that allows to organize cultivation activities, store rainwater, and operate irrigation systems in dry periods [16]. Therefore, there is a further increase in efficiency as there is a reduction in the resources used.

Deep neural network technique [17] improves the yield of the soil thanks to an efficient use of fertilizers. To ensure the survival of the greatest number of plants, traditional agriculture applies pesticides throughout the plantation. Thanks to IoT, it is possible to apply exact pesticides quantities required to prevent and cure diseases plant. Automatic pesticide distribution system identifies areas analyzing satellite image and there is a reduction in production costs and environmental impact.

3 Blockchain technology for precision agriculture

3.1 Blockchain technology overview

In 2008, Satoshi Nakamoto, a pseudonym, launched on the market the first cryptocurrency, called Bitcoin [18]. The cryptocurrency is developed on blockchain technology, which allows to make transaction without intermediation service. It is possible to develop disintermediation thank to digitalization of information, which are shared immediately with everyone, who can consult and verify it. Indeed, blockchain is defined decentralized and distributed ledger in peer-to-peer network. Decentralized system avoids the tampering, the counterfeiting, and the loss of data because each node has the entire chain on its server. Distributed structure is devised as a trustless system, in which it is possible to operate without intermediation services. Indeed, each node has the same power to make decisions, to implement operations and to subscribe them with the other nodes [19].

The most well-known peer to peer networks are two: public and private blockchains. One is public networks, also called permissionless, which allow everybody to access freely. Examples are Bitcoin and Ethereum, which have public blockchain because they are intended as currencies and need large diffusion to serve that purpose. In other hand private networks, also called permissioned, are made up of nodes, which are authorized to access; for example, they could be used by private companies who aim to protect business secrets to potential and current competitor, for this reason permissioned blockchain could be a solution [20].

Block validation takes place with Proof of Work (Pow) [21]. When a node wants to insert new data in the blockchain, he sends an encrypted message to the network. Nodes are incentivized to intervene in the mining process, as the first who can decode this message, called miner, receives a reward. The miners share the decoded message with the entire network. If major part of the nodes approves the operation, a new block is added to the chain. The mining process is expensive due to the large computing power necessary in relation to decision timing to approve an operation and in term of energy's expenditure. So, block validation can be done with Proof of Stake (PoS) [22] identifying small number of nodes, chosen in random way, which deal with mining process could reduce energy's cost.

When data is approved by network, it is inserted and forms a block of the chain. Every block contains a unique number, a hash, which is the link with the previous block and the connection with the next one, timestamp, which identifies in chronological manner [23].

Blockchain, which became famous for the cryptocurrencies birth, is a technology that can be implemented as well in other sectors. In public administration, blockchain can make a great contribution to management and to preservation administrative registers, authentication systems and digital signatures. Moreover, blockchain's introduction could be used to exercise of democracy through electronic voting. In the healthcare sector, peer-to-peer network would determine single file for each patient to have a complete information and improve doctors' diagnosis. Furthermore, data's incorruptibility becomes an optimal solution to limit litigation establishing who was the first subject to register the patent, trademark or other property rights. In the end, agri-food information's request, starting from ingredients to end with production's environmental impact, can be fulfilled by blockchain's implementation [11].

3.2 Supply chain traceability

Nowadays society is characterized by low trust, long shipping distances, high complexity and long processing times, which are food supply chains issues. It is possible to find solution to use blockchain technologies, which offer an opportunity to tackle these problems. Therefor data produced using smart sensors, drones and satellite technologies included in the blockchain, allow to create product's traceability. Currently product traceability is loudly requested by consumers who are increasingly interested in the product components, execution methods and origin. Consumers awareness led to an increase in production eco-sustainability, labor ethics [24] and product quality. Labor exploitation can be contained with the blockchain-based contracts, which check fairness in payments and taxation. For example, Coca-Cola company adopts blockchain to delimit forced labor at their sugarcane suppliers [25]. Traceability on storage details, conditions (temperature and humidity) and time in transit [26,11], makes supply chains more transparent [26]. Now, consumers can access to information on products by scanning QR codes on the packaging with smartphone. The main advantage is that increased transparency might secure higher revenues for the initial producers because they can place their product on a higher price range, and it is justified by the quality certification provided to consumers [11]. Thanks to immutability and verifiability of data, characterized blockchain technology, product aware of consumers have a good propensity to pay a higher price given the guaranteed quality. Other consideration about traceability's production chain is to improve information security in food supply chain [27]. In this way, it becomes easier to trace food fraud and contamination and to intervene promptly by withdrawing products from the market. For example, Walmart and Kroger are the first companies to implement blockchain technology in their supply chain, for products like Chinese pork and Mexican mangoes [28]. Traditional methods take 6.5 days to trace the whole length of mango supply chains, while with blockchain information is available in few seconds [29]. Another case lay in maintaining cold chains, ZetoChain

monitors maintenance of perishable food products through IoT devices in the distribution logistics of cold chain.

3.3 Technological tool for decision making

With the use of ICT, the company can collect information for various parameters on crops, pesticides, fertilizers, machinery, weather conditions, animals [11], necessary to make decisions that allow to improve the quality and quantity of agricultural products [30]. One of key choices agricultural firms must make is the rotation of cultures on the soil. Moreove, choice of culture given a type of soil, exposure to sunlight and the targeted use of fertilizers and pesticides allow to reduce pollution and can have an impact on the finished product. Using blockchain it is solved issues of centralized database such as tampering, counterfeiting and losing data thank to decentralized and distributed ledger, which guarantee immortality of data. The operational planning can use information produced by WSN and ICT wireless sensors to optimize the irrigation process to increase the yield of the collection by reducing the use of resources. [31]. Many researchers developed models to make forecasts more accurate, necessary to make daily decisions about the use of water and energy. Smart Watering System uses blockchain and a Fuzzy Logic approach that can help farmers to acquire objective data from plants and the environment which can be used to make effective decisions about optimal irrigation programs [32]. AgriProduction [33] is another system capable of anticipating agricultural problems related to soil moisture, temperature, and leaf growth, based on both LoRa IoT technology and the ARIMA forecasting model.

3.4 Coordination and cooperation between farms

The agri-food sector is mainly composed of small and medium-sized enterprises. In Italy, 95% of companies operating in the agri-food sector are micro-enterprises. Companies are encouraged to create collaborations and alliances with ICT's use providing information on cultivation and market [34]. The digital platform (DP) creates networks and cooperation forms in the maize crops' value chain [35]. Individual farmers increase supply chain crops value through cooperatives. For example, small African cooperatives use the AgriLedger, blockchain platform to increase trust among each other. Davcev, Kocarev, Carbone, Stankovski and Mitresk, [36] proposed the application of reliable cooperative services within the agri-food chain, among farmers and other entities in the supply chain. Blockchain could be very useful for such cooperatives because the transparency of the information involved could help to resolve disputes and conflicts between farmers in a more equitable way for everyone [37]. Provenance, ArcNet, Bart.Digital and Bext360S are startups offering tools support to smallholder farmers to increase goods' traceability. For example, Soil Association Certification with Provenance invented pilot technology to track organic food's supply chain. These examples underline how blockchain incentives synergy, innovation economic development through cooperation intra-company [38].

3.5 Limits of Blockchain

Blockchain's limitations are scalability and latency, which are interconnected problems. Scalability problem means technology doesn't support data's large amount, which has impact on latency, which is delay in the approval process of a new node. As the blocks, that form the chain, increase, mining process' timing expands and it leads to raise high energy needed to use technology [39]. The agri-food supply chain produces large flow s of data, which fails to be supported by the blockchain structure due to scalability and latency's limits [39]. A relevant technical limitation is interoperability, which is difficult to interconnection between different devices and, so, potentialities of one technology aren't exploit by others.

Sharing data doesn't consider privacy problems because company don't decide which people can access or not to information [39]. Other limit is agri-food sectors is very competitive and farmers aren't incentivized to cooperate, so they don't adopt blockchain technology [40]. Another problem, hardware and software tools are essential to use blockchain and these tools need continuous maintenance, which generates a financial issue. Farmers are concerned about payback times and difficulties of use [41]. Being the blockchain a technology of the latest generation and used in niche markets, the knowledge of its advantages and use cases is limited to a small number of people. Therefore, economic policies and financial and non-financial incentives, such as training, could play a significant role in its dissemination [41].

4 Research methodology

After reviewing scientific literature about emerging technology introduced in agri-food sector, in particular blockchain, a web-article published in January 2022 about precision agriculture had our interesting. It is our first step to start qualitative analysis. In this paper the research method used is the case study, which is an inductive qualitative approach characterized by "*observing the facts, questioning the workers on subjects that could not be directly observed (interview), and collect information*" [42]. Indeed, the case study is based on the qualitative description of a case, which is a small representation of reality, through heterogenic materials from different authoritative sources, such as the interview that allows us to deepen the information of the object of study [43]. In this paper the contribute of qualitative analysis is to describe a small entrepreneur reality with business organization's glasses. Moreover, the potentially of case study is to enter in contact with environmental in order to investigate phenomenon. In the beginning of research, scholars have a theoretical view about phenomena and when they compare it with complexity of reality, they could underline limit of theorical simplification and explore other scientific way to explain it.

Anyway, there are limits in qualitative method such as: (i) difficulty to compare outcomes of research; (ii) subjectivity of revelation data, which can be influenced by scholar point of view; (iii) ambiguity of words, which can have different meaning.

Our research focuses on the use of emerging technologies, such as the blockchain, for enhancing precision agriculture in the agrifood industry. Based on the case study method, we selected and analyzed in a deep way the case of BioLu, which is one of the

smarter farms located in the Campania Region. After collecting interviews published on website, we contact entrepreneur of BioLu to have semi-structured interview in remote way, in June 2022, to get more information about the farm, the technologies used, and effects on consumers, organization, and supply chain in the agrifood.

4.1 BioLu Smart Farm

BioLu is a smart farm founded by Nadia Savino. Businesswoman responded to the Demetra Call, which offer training and mentorship for 8 months to develop innovative business idea in Campania Region. Indeed, this call is organized by SEI, business incubator founded in Avellino that deals with promoting self-employment and the training of young talents. Founded in 2017, BioLu cultivates ancient crop in danger of extinction on a rural area of 27 hectares land between Gesualdo (AV) and Calvi (BV), which are two small villages located in the South of Italy.

The company aims to recover biodiversity by bringing back ancient crops, such as the durum wheat like Saragolla and 'Senatore Cappelli', as well as the soft wheat like Gentil Rosso and Risciola that were cultivated in Irpinia since 1500. To prevent harm to the local ecosystem, Germplasm Bank of Acerra ensures that seeds have no genomic interference with other species and that they have been in the Campania Region for more than 50 years. In the last 5 years, soft wheat Romanella has been planted as well to recover the crop.

BioLu is a small farm with 5 workers, of which (i) a farmer, (ii) a warehouse worker, (iii) an employee for product certification, (iv) a sales manager, and (v) an account manager, that, apart producing wheat, also sells ancient grains' flours and finished products such as pasta, sweets, and savory bakery products typical of the Campania tradition. BioLu grinds wheat in a small, trusted mill and flours produced are transformed in the maternal pasta factory namely Regina Blue. BioLu farm produces spices with Gesualdo celery (which has had the recognition of 'Slow Food'), red *papacella*, Campania pepper, *seccagno* tomato and pomace of *piedirosso sannita*, used to make desserts. The production of a peculiar extra virgin olive oil, namely Ravace, originated in Irpinia by the early sixteenth century, is an ancient olive cultivar, appreciated for its organoleptic proprieties. BioLu farm is digital native and agricultural products were only sold online. Now, BioLu products can also be purchased in retail stores such as wine bars, neighborhood shops, and specialty shops. BioLu works to develop its network of Italian retail stores in order to increase clientele. BioLu collaborates with the AliBaba and JB.com platforms which give BioLu's niche products the opportunity to be known and sold all over the world.

4.2 Emerging technologies in BioLu

The management of BioLu's cultures is based on precision agriculture with two weather stations connected in IoT to the xsense probes and cameras located in the various part of land. Data are sent to the cloud which collect the climatic and visual information. Data transmission allows to have a continuous monitoring on leaf water stress and, if necessary, automatic irrigators water the crop. Near infrared spectroscopy (NIR)

records crop's humidity. Indeed, to collect crop, moisture must be low to avoid the proliferation of organisms harmful for wheat because storage does not involve chemical agents in the biological agriculture. Technologies provide data to the company to support decision making of the entrepreneur on how and when to intervene to have a higher yield of the crop, avoid crop losses and prevent diseases. Hyper-hi-tech olive construction of 200 olive trees has trap installations to capture flies, count them and decide when to intervene. Instead of following a set calendar for interventions in the crop, the farm relies on information collection to estimate the right moment for certain processes. Fertilizer, for example, would only be distributed if the plans and soil require it. Because of all these aspects, precision agriculture has an impact on costs and on environment's footprint; it makes production more effective and efficient.

Farmland notebook, in which are reported phases from sowing to harvest, is drawn up by extrapolating data from the cloud. Furthermore, blockchain contains information from the digital farmland notebook and additional information on the nutritional properties of product and recommendations for consuming it. However, there isn't artificial intelligence software connected to the IoT and blockchain acquires data in a manual way based on human intervention. It happens in many small companies because that cannot support the costs of automating the data collection and transfer processes.

Although the BioLu has implemented the blockchain for serving activities related to the core cultivation of cereals, collaborating companies for milling and making finished products don't use blockchain now. Even though blockchain is mainly used to track the product for the consumers, the entrepreneur Nadia Savino underlines how the blockchain is still little known by consumers, who don't have the culture of scanning the QR code to find out information about the product they are buying.

4.3 Open projects In BioLU

It is important to mention partnership between BioLu farm and the University of Pisa, which experience BioLu products' effects on the health of people with oncological diseases, diabetes, obesity and receive the 'low glycemic index' label. Indeed, ancient wheats has a low gluten content, and they are rich in fiber, ideal for a balanced diet.

Moreover, BioLu is careful to use eco-sustainable packaging. However, even today, plastic is the only material that allows storage times longer.

Future projects concern carbon credits and NFTs. Eco-sustainability of BioLu could become profitable thanks to the introduction sale of carbon credits, CO2's spread between BioLu and mainstream company in the same sector and the same size. When it will become possible to trade CO2 emission rights in Italy, eco sustainable companies can be determinate with information reported in blockchain technology, in which rights can be exchanged in safety way. BioLu intends to develop NFTs related to the limited production of Ravece oil, a typical Irpinia oil. Entrepreneur would like to commission a painted to illustrate BioLu farm mission. Ownership of painting is represented by NFT, additional benefit to the Ravece oil purchase.

5 Discussion and conclusion

The aim of the paper is to understand how emerging technologies, such as blockchain, affect business organization, as well as the effects of usage on consumers, on upstream and downstream companies, and more in general, on the supply chain in agrifood industry. It is important to underline how technologies is adopted by company to improve production organization, in particular precision agriculture was born to maximize output thank to uses of ICT. Indeed, huge amount of data is elaborate to have information, real richness of company, necessary to make decisions. Limit of centralized system and the growing attention of the consumers in which product buy should take companies to invest in technology like blockchain, which ensure trustworthiness of information and their verifiability. Moreover, the IS and managerial literature pointed out how blockchain technology improves organizing, production, and commercial issues. So that, the implementation of emerging technology makes organization structured to monitor production processes avoiding inefficiencies and to intervene promptly in order to protect the yield of production.

As well as blockchain technology allows to have transparent supply chain thanks to the traceability of the data provided to consumers with QR code added on goods, increasing the relationship of trust with consumers. In addition, the use of the blockchain provides the development of inter-company relationships allowing the creation of new business models aimed to incentive collaboration to foster synergy, innovation, and economic development.

Case study of smart farm BioLu uses the information obtained from the collected data for decision making, indeed tracking data over time allows farm to predict events and make accurate choices. Moreover, entrepreneur Nadia Savino underline distrust to welcome new technologies of the agrifood sector and how the implementation of the blockchain requires need a cultural revolution to understand the advantages of technology. Technology advantages aren’t only for internal organization, but it is a strategical way to create verifiable systems of information give to customers.

When consumers' attention is oriented to have detailed and certified information about products, companies will adopt blockchain to track data and share them. Furthermore, it isn’t useful to report huge data recorded in the cloud in blockchain because of consumers are not able to understand them generating confusion in who reading. Thus, it is essential to give costumers reliable brief information and it will become a challenge to understand how select data in blockchain to give information in relation to the reference target such as customers, suppliers, network companies. Today consumers scanner QR code on goods and they have information which companies want to show about their products, maybe in the future customers could be blockchain user, who access to data and query what they are interesting to know about. Moreover, the BioLu case study brings to light the little widespread of blockchain adoption, in fact the technology is adopted to track the cereal production in BioLu farm. Since farms are small and supply chain is short, the main purpose of the blockchain in agrifood shouldn't focus on transparency however coordination between the various players in the supply chain. The blockchain could become the means to improve partnership and coordination between

small agricultural companies in order to compete with large industrialized companies in terms of good quality and production sustainability.

After, analyzing the BioLu case study, limit of interoperability is came out, indeed blockchain doesn't interact with other smart devices used in the farm. Indeed, precision agriculture data is recorded manually into blockchain in such a way that trustless system couldn't be created because there are human discretional actions. However, it isn't a solution record every data in blockchain platform because scalability don't support a lot of data and while records is increasing, it is necessary to spend more time and more energy. It is necessary development of the automation data inserted in the blockchain, which allow greater reliability. The future of research will be to understand how create automated tracking system integrated in the blockchain technology obtaining decentered and distributed database. A possible solution could be software able to elaborate data in the cloud and create digitalization farmland notebook, which is automatically put on blockchain.

For the future research, it will be useful understand how be able to overcome the cultural barriers of the agrifood sector, which makes the adoption of blockchain difficult. In the future we will see the evolution of emerging technologies, such as blockchain, and their ability to adapt to the needs of reality or the possible birth of new devices capable of fulfilling the needs of the system.

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