Blockchain Applications in Agribusiness

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Blockchain is a communication network where data is stored and shared in a distributed manner among all its nodes and links, eliminating any reliable authority centralized in different business models and where each node can assume coordination without a unified data center.
Blockchain is a chain of blocks of information forming a distributed database where a group of people controls, records, and shares information used in various types of applications and is interconnected through platforms and hardware worldwide.

Internet of Things | information technology | innovation | supply chains | transparency | traceability | safety | food systems | transactions | smart contracts

1. Introduction

Agribusiness is a sector of paramount importance for a country; its potential results from a set of several factors, especially investments in technology and research, which can increase productivity. The agribusiness aggregate is composed of several inputs or product supply chains operating in different natural ecosystems. The supply chains are embedded in an institutional environment formed by financial, R&D, and technical assistance organizations and institutions with a strong influence on their performance [1] and the operations involving everything from the manufacturing of inputs, production on the farm, transformation process (industrialization), distribution, and trading to reach the end consumer[2].

A farm represents an important node, integrated with other nodes such as infrastructure, commerce, finance, technology, labor relations, and the entire public and private institutional apparatus [2][3]. In addition to the number of actors and transactions, their complexity is increasing over time, taking into account the countless amount of country-specific economic, political, environmental, social, cultural, legal, and sanitary norms and conventions [3].

The flow of products and services in the agribusiness supply chains occurs in one direction, while in the opposite direction, there is an exchange of financial resources. In both directions, there is a constant flow of information [4][5]. Information sharing is subject to many benefits and restrictions, depending on the objectives, interests, technology, trust, and control that exist between the actors [6]. The asymmetric nature of information and misinformation is a constant challenge to be overcome in supply chain management, and consumers are demanding traceable products, transparency, and safety information [7][8][9][10]. A Blockchain pode ajudar a resolver os atritos entre a

demanda e a oferta de produtos e serviços nas organizações [10]. Blockchain can help resolve friction between supply and demand for products and services in organizations [10].

Blockchain is considered a technological innovation that comes from incorporating existing technologies and, lately, has received more attention due to its autonomy, anonymity, and data immutability, becoming an emerging subject in science and organizations [11]. Blockchain is claimed to be a technology of inviolable validation, having decentralization as a safety measure that creates consensus and confidence in direct communication between two parts, without third-party intermediation. It is appropriate for situations requiring privacy, identity control, and permissions [12][13].

Many organizations have integrated technologies that have been changing the environment and markets, making it easier to develop activities favoring all parts of the process, including the agribusiness segments, resulting in positive contributions to the agri-food supply chain. Combining the particularities of supply chains with the characteristics of Blockchain, there is a great potential for applications of this technology to solve problems in various areas of agribusiness. Blockchains can improve traceability in agribusiness and add value for the producer and the entire production chain. Thus, an infrastructure supported by this technology can help guarantee food safety, as effective tracking reduces losses in the logistic process [7][8][9][10][14][15][16][17][18]. Like traceability, Blockchain has the potential for many other applications in agribusiness. In this study, we seek to identify the main applications reported in the scientific literature.

2. Main findings

Blockchain applications in agribusiness supply chains are only in the early stages. The development and applications of Blockchain have been interdisciplinary efforts, given the diverse areas of knowledge involved. Blockchain is a technology that needs software developers to create programs and algorithms that adapt to the specificities of each application. Therefore, Blockchain is still in an exploratory phase where the development of technology precedes its application.

Blockchain applications are pointed out in several sectors, including finance, in which a significant percentage of networks were formed and used Blockchain 1.0 for cryptocurrency [19][20]. Others are categorized according to versions “2.0 and 3.0”, which are smart contracts encompassing all the financial and economic areas with efficient applications in economics, markets, general sciences, and the governmental regions [21][22][23]. A scheme of the purposes for which Blockchain has been applied in agribusiness was constructed to analyze the selected articles and is outlined in Figure 5. The purposes are related to finance, energy, logistics, environment, agriculture, livestock, and agroindustry management, with specific uses within each segment. It is important to stress that blockchain implementation has been identified in some supply chains, but prototypes are still in the laboratory tests and applications phase.

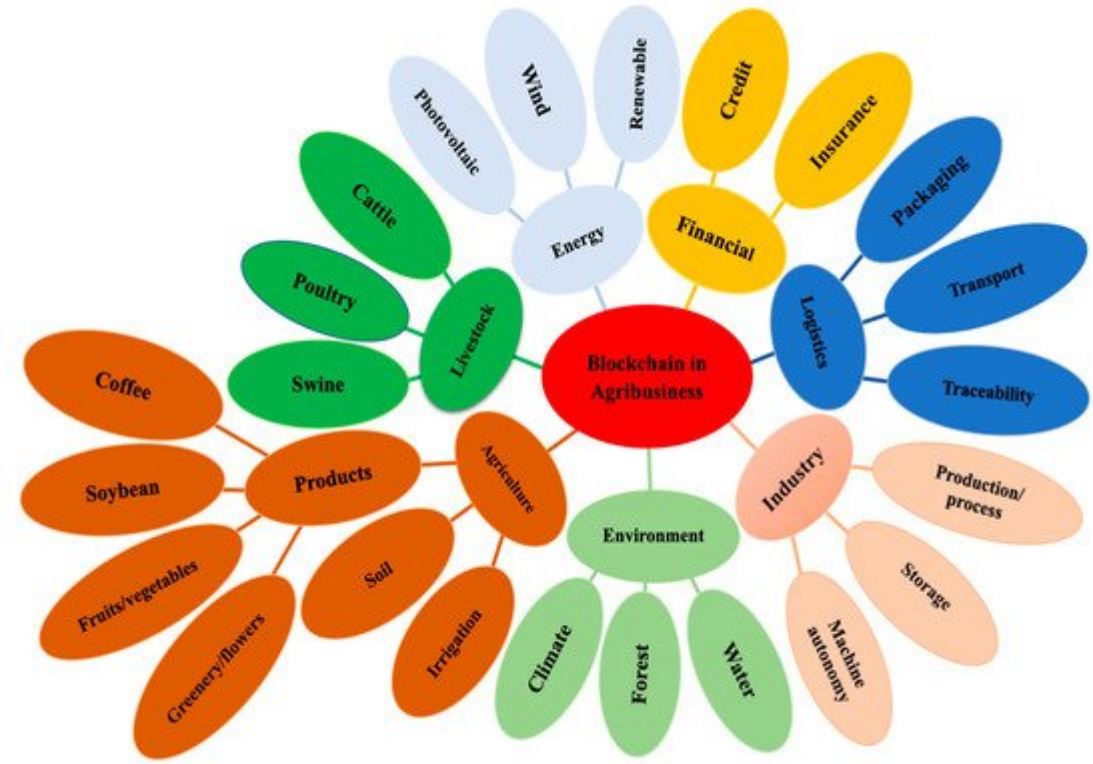

Figure 5. Blockchain applications in agribusiness

Finance. In finance management, Blockchain allows the reduction of information asymmetry, establishing a fluent channel for transmitting information, increasing the reliability of transactions, improving efficiency, and reducing the costs of agricultural financing [19][20]. The mechanisms for recording, storing, validating, and protecting data aim to solve financing problems between all actors in agricultural supply chains. This includes farmers, development agencies, banks, insurance companies, and other financial institutions [19][20].

Energy. Agriculture is a major consumer of energy, requiring the efficient management of energy resources in agriculture is a fundamental requirement. Thus, Blockchain can improve local energy consumption, reduce costs with energy purchases and losses, and improve the grid voltage on farms [24].

Logistics. Blockchain has the potential to facilitate and streamline logistic processes in agribusiness supply chains, and these processes can be reproduced in real-time due to complete digitalization and its automation. Besides, smart contracts optimize and make financial transfers easier [25][26][27]. Smart contracts generate a guarantee of a direct network between the incoming and outgoing goods, and payment operations can be carried out with more autonomy and efficiency. Traceability via blockchains allows the consumer to track the food from its origin to retail marketing, where information can be shared securely through a blockchain [28]. The Blockchain technology system achieves a better level of efficiency for logistics and operations.

Environment. Blockchain can monitor data on the adoption of ecological and sustainable practices in supply chains [29][30]. It is also possible to adopt it as a complementary payment currency for environmental systems (PES),

unattached to the traditional financial system [31]. The applications related to environmental management are focused on forest mapping, traceability and climate, and soil control.

Agriculture. The agricultural sector has adopted different technologies, such as the Internet of Things (IoT) and Blockchain, to reach higher yields in production processes [32] and track products from the farm to the final consumer [12][33][34][35]. Blockchain, together with IoT, contributes to the resolution of challenges related to operation safety, quality certification, and product origin. Processes involving food security, production, processing, and transportation, in addition to transparency, security, neutrality, and reliability in the information passed on to other links in the supply chain, can benefit from the adoption of Blockchain.

Livestock. The livestock sector is in constant evolution, requiring effective alternatives for its process and management. Blockchain can help solve the problems between supply and demand in the supply chain, reduce transaction costs and improve transparency among the actors involved, and improve the traceability and monitoring of animal welfare [36][37][38]. Among the benefits are time, money, and improvement for the whole chain through efficient management of the farms.

Agroindustry. Blockchain can be used in the food industry differently since production goes through processing and final packaging to the consumer. Studies have been carried out focusing on this sector using. For example, two-dimensional bar code (QR Code) technology can be used in many product packages since it makes it possible to save a variety of data in a minimal amount of space. The final consumer can view the whole history of the product, from production, processing, to final packaging, on a smartphone [39][40].

3. Conclusions

The application of Blockchain in agribusiness is still very recent. The development of technology advances in science first, but it is already possible to identify practical applications in agribusiness supply chains, even if in an incipient or experimental way. We have identified cases of laboratory prototypes in the application testing phase. There are several applications of the technology in the “proof of concept” phase, and few are implemented on a large scale.

Among the main Blockchain applications in agribusiness supply chains, we identify finance, energy, logistics, environment, agriculture, livestock, and agroindustry management. The objectives are not independent or mutually exclusive. On the contrary, the application of Blockchain in agribusiness supply chains can cover several links and serve different applications simultaneously. For example, blockchain applications for logistical purposes can also result in energy, financial and environmental advantages. There are other possibilities of application since its potential may not be estimated correctly, as it is a technology that is still emerging.

Blockchain provides greater privacy due to strict controls made safer due to data immutability. Its application in agribusiness has several advantages, such as increased reliability, reduced risk in transactions, reduced bureaucracy, reduced costs with the elimination of intermediaries, reduced fraud. Besides, it allows transactional

processes to become simpler, faster, more secure and reliable. Such benefits are implicit in the high frequency with which Blockchain appears associated with traceability and smart contracts. It is concluded that Blockchain is an incipient technology. Still, its characteristics and the results of this study allow us to affirm that its application in agribusiness tends to grow significantly in a short time. Indeed, we face a technology that will have an enormous impact on the transactional and agribusiness management processes.

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