

Blockchain in Revolutionizing the Agricultural Sector

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Distributed Ledger Technology (DLT)/blockchain is an intriguing new technology that has the potential to be a game-changer, and, in general, DLT are tamper-resistant and time-stamped databases. They allow several parties to capture, validate, and distribute data over a network in a decentralized, synchronized, and transparent manner, with minimal human participation and intermediate processes. The application of blockchain agriculture is still in the early stage, although there are ongoing research, projects, and initiatives to gain the most benefits of introducing blockchain-based technology in agriculture. These ongoing processes are centered around topics such as traceability, transparency, credibility, and auditability of agricultural data via blockchain based technology. Moreover, they are developing useful models or applications that can be used to improve the performance of the agriculture sector.

Keywords: blockchain ; agricultural sector ; artificial intelligence ; food supply chain ; digital agriculture

1. Introduction

DLT (Distributed Ledger Technology)/blockchain is an intriguing new technology that has the potential to be a game-changer ^[1], and, in general, DLT are tamper-resistant and time-stamped databases ^[2]. They allow several parties to capture, validate, and distribute data over a network in a decentralized, synchronized, and transparent manner, with minimal human participation and intermediate processes ^[3]. Blockchain has the potential to alter the present economic and commercial paradigms, such as how the steam engine and the Internet sparked past industrial revolutions ^{[4][5]}.

Many industries, including the financial sector, energy markets, supply chains, intellectual property management, 'virtual enterprises,' the public sector, and beyond, could benefit from blockchain technologies. ^[6]. Its capability to lower transaction costs, inject efficiencies into existing value chains, challenge revenue models, and open new markets is due to its ability to de-intermediate, improve transparency, and boost the ability to listen ^{[7][8]}.

A blockchain is a distributed database that is shared across a network of computers. It is possible to contribute to the database but not to edit the existing data ^[9]. The database's legitimacy is checked on a regular basis by the network. While the most well-known application of blockchain is in the cryptocurrency Bitcoin, it is currently being employed in a variety of other ventures ^[10]. It is the platform's core technology that enables the creation of a safe means to record transactions and distribute them to signatories or any other target group with an Internet connection. It is, at its core, a highly democratic ledger that cannot be changed arbitrarily and is easily shared ^{[11][12]}.

Blockchain offers the potential to improve financial management, origin, traceability, and transparency in food chains, as well as enable the creation of new markets and products, for agriculture in poor countries ^{[13][14]}, since humanity deserves the best in terms of education, business, health care, and, even, grocery shopping. We always have fresh fruits and vegetables, dairy, and meat to live a healthy and delightful life, thanks to agricultural advancements.

2. Blockchain in Revolutionizing the Agricultural Sector

2.1. The Use of Blockchain in Agriculture

The transmission of encrypted information is vital to every part of our modern life. Agricultural stakeholders want their personal data to be stored securely and not disclosed to third party companies and persons. That is exactly what blockchain provides—the effective protection and secure exchange of data ^{[15][16]}. Since the information in the network is written in blocks, it cannot be easily modified or read if access is not permitted. Moreover, all data are stored on decentralized networks that reduce the risks of hacking and fraudulent activity ^[17].

Currently, the blockchain network is predominately used in the financial field to monitor and confirm transactions as well as improve their speed and security ^[18]. The banks that have tested this technology appear to be quite satisfied with the

results. Blockchain also helps with document verification and confirmation, as well as helping to speed up logistics processes ^[19].

However, how useful is a blockchain for agriculture? As mentioned, the network is great for accelerating and securing financial transactions—in the same way that it may help solve problems related to the financing of agricultural projects and lead to the further development of the entire industry ^{[8][20]}. The blockchain allows to control and accelerate the daily operations of the industry such as production, transportation, food processing, storage, and sale ^[21]. Blockchain technology is also great at solving problems related to the growing population, and, thus, the demand for food and the demand for quality products: first, logistics can be efficiently organized, and financing can be purchased using this network. Second, blockchain can be useful in determining food quality and preventing fraud ^{[22][23]}.

In addition, the blockchain has a significant impact on the arrangement of the supply chain as a transparent and secure data exchange network that greatly simplifies cooperation between farmers, carriers, and customers ^[24]. This is vital for products with short expiration periods, as it helps reduce expenses and, therefore, the overall price of these products. When using the system, the farmer must enter all the details about the products they sell, as no one can remove or modify them, and, therefore ^[25], it will not be possible to sell the same dozen eggs twice—the system will detect fraud from other users. In addition, if the farmer is required to enter all product details, the system may be vulnerable to the submission of fraudulent or wrong data, which will become immutable ^[22].

2.2. The Benefits of Using Blockchain in Agriculture

The blockchain approach alone does not guarantee that farmers' income or beef quality will improve. The technology, instead, is rather a tool for automation, traceability, quality assurance, and more. With this technology, improvements in this area can be experienced ^[14]. The blockchain network may have some advantages when applied correctly in various industries, including the agricultural sector. For example, these benefits could be explained as the following:

Transparent supplemented

Some customers want to know where the food they buy is grown, how it is delivered to the store, and whether the products meet quality standards. Due to blockchain technology, this information is accessible, and customers understand that it cannot be modified or hidden invisibly ^[22]. In this approach, if a QR code label is placed on, say, a beef package, the consumer may verify not only the animal's living conditions but also the shipping data, storage duration, and many more details ^{[26][27]}.

Secure system

The data on the blockchain network cannot be changed without the permission of both the seller and the buyer ^[28]. As a result of this technique, a dependable system that protects users from fraudsters and prevents fraud is created, which is a kind of system that is trustworthy to its users. The dependable system requires that the system be highly available (to legitimate users) while ensuring a high degree of service integrity ^[29]. For example, it is difficult to make a price decrease or increase without first discussing the pricing and finding a qualified team of software developers with reasonable rates reasonable portfolio that includes agricultural experience. For example, the company should be able to provide a well-designed and high-quality product with the required set of data records ^[30].

Encourage investment

Owning a small business is often difficult. Finding loyal customers and establishing operations takes one to two years, and it can be challenging. Using blockchain technologies, small farm owners will be able to find investors and improve their business with the help of the Initial Coin Offering program (ICO), which is a type of funding similar to crowdfunding, with crypto currencies instead of regular payments ^[31]. All that needs to be done to turn ideas into reality is to convince people to invest in the project, although ICO is not regulated and guaranteed by the government, so startups do not need to cover additional legal expenses or hire a lawyer ^[32].

Implementation of smart contracts

Smart contracts are written code developed by software developers that are connected into the network, and the technology itself considerably simplifies the process of delivering food and collecting the payment. Farmers do not have to wait weeks or months for their money to be returned; transactions are performed immediately, once the products are available. Furthermore, there are no intermediaries involved. As a result, farmers and their clients may be assured that all obligations are met ^[8].

Stock market for farmers

Blockchain technology is represented on exchanges as well. Their operations remain the same, however, and stock markets can now benefit from the blockchain. Farmers can easily trade upcoming contracts at fixed prices for crops, livestock, fruits, vegetables, and other agricultural products. As a result, farmers will know their cost, and customers will not be surprised by price changes ^[13].

Agricultural cryptocurrency

Blockchain technology is often used in the context of Bitcoin and other cryptocurrencies. So, when it comes to the agricultural field, the PavoCoin—a digital currency similar to Bitcoin, developed and designed specifically for farmers. It provides a secure payment method throughout the entire system. The currency is used to increase transparency as well as speed up and simplify customer interactions ^[33].

2.3. Blockchain Use Cases

Trace the food source

Stores must maintain all required certificates and other documents that may be requested when purchasing food or other products. However, these documents do not say for sure whether it was a sick chicken or cow, how it was fed, and so on. In the future, blockchain networks should enable users to find all relevant details regarding food production and transportation, thus saving them time when researching the history of the products purchased ^[34].

The blockchain system maintains all records without hidden modification, and a full description of the food's origins will be received—right on the smartphone, which is fast and easy. Thus, increasing the probability that the food purchased is safe and healthy ^[34].

For example, the technology is used by Walmart to supply livestock products from China and mangoes from Mexico to the United States. Walmart and IBM are currently working on a blockchain-based agricultural supply chain to apply transparency for retail customers ^[35]. The system encourages all parts of the “food chain” (farmers, suppliers, businesses, etc.) to enter their data into a single database based on the blockchain network.

The number of agricultural and food companies using the system is increasing daily ^[36]. For example, IBM worked with ten of the world's largest consumer goods and food firms to integrate blockchain into their supply chains. Walmart, Nestle, Unilever, McCormick, Tyson, Kroger, McLane, Driscoll's, Dole, and Golden State Foods ^[37] are among the companies that collectively generate more than half a trillion dollars in yearly global sales, so IBM's blockchain platform will assist food industries in increasing supply chain visibility and traceability as a result of the agreement. Maybe some of those companies will soon start accepting payments in Bitcoin and other cryptocurrencies ^[38].

Prevent counterfeiting of raw materials

It is impossible to grow healthy livestock or plants if the purchased seeds and grains are of unsuitable quality. Moreover, low-quality materials may affect the farmers' business and lead to large expenditures ^[39]. Certainly, both small and big farmers are interested in buying quality products, and this is where the blockchain system comes into play ^[14]. This way, in the event that suppliers provide low-quality seeds, this information will be reflected in the network for other users to see. Not only customers, but also the farmers themselves, will be able to check all the black spots of the product they are going to buy, enabling farmers to make more informed purchased decisions.

The IBM blockchain technology used by the extension, for example, is predicated on transparency, revealing farmers' records and locating their produce in real time. Records reflecting the flow and conditions of product transportation may be examined, as well as sources checked and vital ingredients used, plus many other facts can be known with the help of this platform ^{[14][22]}.

Decentralized organizations

Small businesses and utilities are being displaced as large corporations gain a larger portion of the market. Companies dictate terms to small farmers, deciding what to cultivate, how to grow it, setting pricing, and so on. Farmers that rely on these clients and suppliers are not allowed to set their own terms because they risk losing too many orders. It is feasible that we will see a situation where the blockchain system allows for rule changes in the near future. Small firms can work directly with new clients, find permanent employment, receive finances, and, perhaps, create their own conditions of

operation in this environment. In addition, consumers may receive high-quality products at reasonable prices while being confident that they are secure ^{[40][41]}. Not to mention, there are other obstacles in agribusiness, such as transportation and distribution, which are handled by traders.

The quality controls

The combination of IoT technology and the blockchain network provides a secure storage system for information about livestock, crops, and other aspects. Using specific sensors, soil quality, a variety of pests, irrigation, and many other factors can be monitored on special phones or tablets ^[42]. These sensors send collected data to the cloud storage in the blockchain ^[43].

The Flux development team (an Israeli company) is currently working on a blockchain-based solution with the goal of creating a combination of IoT technology and artificial intelligence ^[44]. Eddy, the world's first Growbot developed by Flux, is specifically designed to ensure successful harvests and increased yields.

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