

Blockchain Technology in Agriculture: Enhancing Transparency and Traceability

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Abstract

Blockchain technology has been a game-changer in a number of sectors, including agriculture. This study examines how blockchain technology could be used in agricultural supply networks, emphasising how it can improve efficiency, traceability, and transparency. Every individual involved, from farmers to consumers, can confirm the origin and grade of agricultural products through blockchain's immutable record. Increased transparency can boost consumer trust, improve food safety, and lower fraud. In addition, smart contracts can streamline operations and eliminate expenses by automating procedures like payments and compliance checks. In order to guarantee that farmers receive the benefits of subsidy programs, blockchain technology can also be used in the transaction process. These studies indicate that although obstacles like legislative frameworks and technology adoption still exist, blockchain has enormous potential to transform agriculture and guarantee a more sustainable and equitable food system.

Keywords: Agriculture, Blockchain Technology, transparency, traceability.

Introduction

Agriculture is the practice of farming, cultivating crops and raising livestock to produce food, fiber and other products used to improve human life. It is a key factor in food security, especially in rural areas and a major contributor to a country's GDP. It also faces a range of problems that challenge its sustainability, productivity and ability to meet global food production demands. There are increasing difficulties from climate change, soil degradation, excessive use of pesticides and fertilizers, biodiversity loss, food security and distribution and intermediaries such as traders, wholesalers, and food processors. While modern agriculture provides a large number of solutions to address the problems caused by middlemen in agriculture. Farmers should adopt technologies like Blockchain to fulfil the expectations of regulators, consumers, food processors and retailers. Blockchain technology is a set off distributed database that stores data in blocks that linked together in a continuous chain. It's a secure and decentralized way to record information that's difficult to change or manipulate.



Blockchain Technology

Blockchain is defined as an individually connected array of blocks, each comprising several transactions that yield a distributed, incontrovertible data store that can be used in a broad range of applications (Fanning and Centers, 2016), including electronic voting, crowdfunding, distributed resources, governing of public records and identity management. Following (Yli-Huumo et al., 2016), currency transactions between individuals or organizations are normally consolidated and managed by a third-party company. Blockchain enables technology to act as the driving force of the next vital revolution within the information technology perspective. The use of data and information becomes increasingly crucial for the agriculture sector to improve productivity and sustainability. Information and Communication Technology (ICT) substantially increases the effectiveness and efficiency of collecting, storing, analysing and using data in agriculture (Walter et al., 2017). It allows agricultural practitioners and farming communities to easily obtain update-to-date information and thus make better decisions in their daily farming (Kaddu and Haumba, 2016).

Impact of Blockchain Technology in Agriculture and Food Sector

Blockchain technology can track the movement of agricultural commodities from farm to table. Each step of the supply chain, from harvesting to processing to distribution, can be recorded through the blockchain technology. It also enhances transparency, reduces scam and provides consumers with complete information about the source and quality of their food. Blockchain can validate and certify fair trade practices, organic certifications and sustainability claims by recording compliance and certification details on the record. Farmers can share agricultural data, such as crop yields, soil conditions and weather data, on a blockchain-based platform to support collaborative research and decision-making. It also promotes precision data, facilitates research, and helps optimize farming practices through shared insights. For Example: Companies like Walmart and IBM have implemented blockchain to trace food commodities such as mangoes and pork. It allows consumers to know detailed information about the product and journey of their food. This improves consumer trust and accountability. The agriculture industry faces food safety challenges due to contamination or spoilage of foods. Blockchain technology helps in tracing of contaminated products more accurately and significantly reducing the risk to public health. Farmers often must wait weeks or months to be paid after delivering commodities. But, Blockchain technology enable immediate payment on delivery and improve settlement process for farmers without delay.

Blockchain Applications in Agriculture

Supply Chain Transparency

Enhancing transparency in supply chain is one of the most important uses of blockchain in agriculture. The supply chain in agriculture is often complex, due to the involvement of multiple intermediaries, such as farmers, distributors, retailers and consumers. Basically, it will be difficult to



track the provenance of food products from farm to table. Blockchain technology provides transparent, unchangeable record of transactions, ensuring the traceability of agricultural commodities.

By utilizing this blockchain technology, each person in the supply chain records their data, then accessed by all the stakeholders, including end consumers. This technology improves consumers trust and confidence in food products, particularly in the case of contamination and fraud. For example, Major food manufacturers and merchants are currently using the IBM Food Trust blockchain platform to enhance food traceability.

Smart Contracts and Automation

A smart contract, also known as a crypto contract, is a computer software that, under certain circumstances, directly and automatically controls the transfer of digital assets between a peer-to-peer networks of parties. Smart contracts can automate agreements and transactions between parties in agriculture, eliminating the need for middlemen and increasing productivity. In this regard, when certain requirements are fulfilled, such as the delivery of goods, payments to farmers can be initiated immediately. In crop insurance, smart contracts can also be used for handling benefits automatically when certain meteorological conditions are identified. This minimizes administrative expenses and guarantees that farmers are paid on time, particularly in developing nations where insurance access is frequently restricted.

Agricultural Finance and Credit

For small-scale farmers, access to financing is a major obstacle, especially in developing nations. By offering a transparent and verifiable record of a farmer's transactions, yields and performance, blockchain can enhance credit availability. Financial organizations may be better able to determine creditworthiness as a result. Additionally, peer-to-peer (P2P) lending can be facilitated by blockchain-enabled platforms, enabling investors to directly fund farmers. In addition to providing farmers with more flexible and reasonably priced financing choices, this can lessen their need on conventional banking institutions.

Sustainability and Resource Management

By monitoring and confirming sustainable farming methods, blockchain technology can aid sustainability initiatives. Concerns over the use of fertilizers, pesticides, water and other resources in food production are growing among consumers and regulatory bodies. Blockchain technology can offer complete documentation of agricultural operations, making it possible to validate sustainable practices. Furthermore, blockchain technology can be used to track and optimize the usage of water, fertilizer and other resources, resulting in more sustainable and effective farming methods. Blockchain-based technologies can help farmers better manage these resources and guarantee that regulations regarding the environment are followed.



Challenges and Barriers to Adoption

Agriculture, with its millions of stakeholders and transactions, will require solutions that can handle large-scale operations. Because, current blockchain systems can be slow and require significant computational power, particularly for larger networks with high transaction volumes. Implementing blockchain technology requires significant upfront costs, including technical skills, infrastructure and maintenance. Small-scale farmers in developing regions may lack the necessary infrastructure, digital knowledge or internet connectivity to adopt blockchain technology. In many rural areas, farmers may lack technical skills needed to engage with blockchain systems. Without proper awareness, training and education, blockchain's potential will remain underutilized in agriculture sector.

Conclusion

The primary objective of this review was to understand the latest advancements in blockchain technology and its applicability in the agricultural sector. In conclusion Blockchain technology has the potential to revolutionise agriculture by improving supply chain efficiency, traceability, and transparency. Blockchain increases consumer trust, accelerates procedures, lowers food fraud, and even makes it easier for farmers to obtain more equitable insurance and financial opportunities through smart contracts by providing safe, unchangeable records. In the end, it promotes a healthier and more responsible agricultural ecosystem by offering useful data for sustainability projects and precision farming. High prices, interconnection problems, and the requirement for stakeholder education and awareness are some of the obstacles that still stand in the way of mainstream use. Blockchain will probably play a bigger part in agriculture as these obstacles are removed and new solutions become available, assisting the industry's transition to sustainability, quality, and economic resilience.