Tobacco Research 49(2): 88-90, 2023

REVOLUTIONIZING AGRICULTURAL MARKETS AND TRADE FOR COMMERCIAL CROPS: EXPLORING THE POTENTIAL AND IMPACT OF BLOCKCHAIN TECHNOLOGY

SENDHIL R

Associate Professor, Pondicherry University (A Central University), Kalapet, Puducherry – 605014, India.

(Received on 10th September, 2023 and accepted on 24th December 2023)

Agriculture supply and value chains are undergoing significant structural transformations in the modern era of the Internet of Things (IoT) and globalization. In response to the challenges encountered in the agri-food system due to the global transition, Distributed Ledger Technology (DLT), commonly known as "Blockchain Technology," has emerged to revolutionize the agricultural markets and trade. Blockchain Technology (BCT) provides a secure digital database for recording agri-business transactions, minimizing uncertainty in trade, expediting transactions from one stakeholder to another, reducing transaction costs at each stage of the value chain, and offering accessibility to all stakeholders in the network.

Agricultural commodities, in general, 'commercial crops' in particular,are characterized by a complex network of value chains with less transparency from plough to plate (having enormous scope for domestic marketing and international trade), adversely affecting the chain actors, especially the producers,processors,and consumers. Strengthening the relationships between input supply firms, farmers, markets, traders,and consumers is crucial to maintaining transparency, promoting economic growth and development, and generating employment. Blockchain has the potential to integrate commercial cropvalue chains, ensure market system transparency, enhance market player efficiency, improve food safety and quality control, increase legal certainty for land ownership, and simplify agricultural finance measures. This allows agribusiness firms to leverage DLT applications, making thevalue chains more traceable and transparent. The BCT is of significant importance for commercial crop value chains, and through its application, the existing drawbacks in thevalue chains, like product traceability, security of product information, and trust building across value chain actors, including the customers for a superior quality product, are addressed.

Blockchain Technology: *Modus Operandi*

The BCT is a modern, cutting-edge technological innovation that increasingly favors networking and utilizes a peer-to-peer validation network to achieve a comprehensive, transparent, and optimized business network. It establishes a fully decentralized system for recording and authenticating all business transactions, ensuring accessibility for all value chain actors. Froma core perspective, BCT serves as a decentralized digital transaction ledger maintained by a network of computer applications, eliminating the need for third-party involvement. Each transaction in the value chain, referred to as a "block," is documented within a software platform, enabling data transmissionfrom one stage to another, processing, storage, modification, and, finally,access by all actors involved in the value chain. Every 'block' contains the recorded transactions along the value chain,including a timestamped header and a link to the previous block. Additionally, each block possesses a hash pointing to its successive block's header, allowing value chain actors (stakeholders) to verify data integrity across each block. The BCT is considered a revolutionary technology in agri-business owing to its multiple benefits. The potential applications of BCT are vast in the agricultural sector, particularly in commercial crops with immense trade potential. In the case of commercial crops, the BCT simplifies and integrates thevalue chain activities. It generates more reliable and securemarket information and paves the way for enhanced market access through traceability, trust building, and consumer satisfaction.

Published already in the ISTS Souvenir

The BCT facilitates secure and transparent end-to-end transactions between the chain actors, ensuring that agri-business transactions are conducted without market intermediaries, such as banks or other middlemen. Besides agriculture, BCT has witnessed significant success across various sectors and organizations, attributing its achievements to its fault tolerance and problem-solving capabilities, which establish trust among key actors in the value chain. The agricultural value chain, being critical and prioritizing areas for a specific commodity group like the 'commercial crops' that have more potential for international trade, confrontsseveral challenges in upholding the food safety and quality standards within the agri-food system.Blockchain is a dependable means of tracing all transactions among the chain actors, mitigating malfunctions, and fostering transparency in the value chain. It enables the recording of every step in the product's value chain, for instance, from tobacco production (including the input supply) to final consumption, offering substantial value in fortifying the 'commercial crop' sector against potential threats and enhancing its intelligence in the era of the IoT and globalization. Precisely, at each stage of product movement, diverse information is encrypted in the blocks using various technologies, hence the name 'Blockchain Technology.' The five features of BCT are decentralization, immutability, peerverification, cryptography, transparency, and anonymity.

Blockchain Technology: Advantagesfor the Commercial Crop Sector

The utilization of BCT in agricultural marketing and tradeof commercial crops yields various positive outcomes and is briefly described below.

- ***Building trust and transparency in marketing and trade*:** BCT ensures transparent marketing and tradeof commercial crops, enabling stakeholders to operate in a secure and integrated system. The transparency provided by BCT supports immutability, security, and the establishment of trust within the value chain.
- ***Direct trade with less or no intermediaries*:** Agricultural marketing and trade heavily rely on intermediaries, and traditionally, agribusinesses attracted customers through information intermediaries.In the case of BCT, itbypasses intermediaries, fostering stronger relationships among core value chain actors. Disintermediation involves eliminating intermediaries,resulting in enhanced efficiency, reduced transaction costs, and stronger relationships between customers and products like premium tobacco.
- ***Smart contract combatsfraudulent activities*:** BCT establishes a 'smart contract' through a transparent and trustworthy digital platform to mitigate the risks. A collaborative platform is operated in an integrated, immutable, and credible environment, allowing customers to trace products and obtain reliable data.
- ***Protecting data privacy and security*:** BCT addresses thecustomers' concerns about the confidentiality of their transactions and the misuse of personal information. The blockchain platform employs "privacy-by-design" technology (decentralized and cryptographic), encrypting stakeholder credentials for safe and secure transactions. Once encrypted, tampering and altering the data is complex, thereby ensuring data integrity.
- ***Improving product traceability alongthe value chain*:**BCTensures a secure and decentralized method for business transactions in commercial crop value chains, connecting all core actors from production to consumption. This unique mechanism enhances the traceability of the products in the commercial crops value chain.
- ***Streamlining market access and compliance*:**BCT provides a standardized and transparent platform to meet commercial crop value chains' regulatory requirements and quality standards, facilitating better market access and trade compliance. Since BCT offers details of all operations along the value chain and more accurate market information, it empowers stakeholders to make informed marketing decisions.

Blockchain Technology: Issues and Challenges for the Commercial Crops Sector

Despite significant opportunities for the commercial crops sector, its adoption may encounter various issues and challenges,whichare briefed below.

- ***Challenges in adoption*:**BCT has to be adopted on a wide scale across the commercial crops value chain. If only a few actors participate due to cost, technical barriers, and resistance to change, the benefits are restricted.
- ***Digital gap***:The Indian agricultural sector comprises largelysmall and marginal landholders (~85%) with a considerable knowledge gap regarding high-end technologies. Hence, efforts are needed to train and enroll producers to take advantage of the BCT.
- ***Governance***:Increased automation may reduce human intervention across the value chain, turning blockchain into a deskilling technology and causing the loss of skilled jobs. In addition, with an increased volume of data, the network may experience delays and increased costs, which may have implications for real-time value chain operations.
- ***Uncertainty in regulation***: The regulatory environment can be uncertain in commercial crops like tobacco, as navigating regulatory frameworks may pose challenges if the guidelines for trade (export and import) via BCT are still under development.
- ***Technical challenges***: The BCT records all business transactions in a common ledger accessible to all stakeholders in the value chain network. However, ensuring the stakeholders' privacy, especially in competitive mode, can be a significant operational and technical challenge. Though several blockchains have been tested on a limited scale in a controlled environment, the concern arises when value chain actors accidentally lose private keys, rendering them unable to manage their accounts. Also, in the case of a public blockchain, sensitive data may be visible to all stakeholders,which warrants careful consideration of their privacy.

Conclusion and Way Forward

Enhancingmarket efficiency and establishing a trusted, transparent environment for a sustainable distribution network integrating all key commercial crop value chain actors requires technological innovation and intervention. Blockchain technology is touted to be a promising innovation in scaling up the business by revolutionizing the existing practices in agricultural marketing and trade. Despite BCT's promise of many benefits, its adoption faces numerous barriers and challenges. Developing policies that promote the growth and integration of blockchain techniques in the commercial crops value chain is imperative, ensuring sustainability and promoting competitiveness among the chain actors. However, certain limitations related to governance, regulation, data privacy, technical challenges,and stakeholder relationships warrant attention. Increased investment in research and education is necessary to address the existing challenges and highlight the technology's potential benefits. Future research efforts should focus on developinga comprehensive legislative framework to position blockchain as aninnovative and cutting-edge technologyfor sustainable and smart agricultural development.