AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 02, Issue: 06 (June, 2025)
Available online at http://www.agrimagazine.in
©Agri Magazine, ISSN: 3048-8656

Block chain in Agriculture: Leveraging Block chain for Transparent Supply Chains, Traceability, and Fair Trade Practices

*Shubham Kumar
MBA-ABM, College of Agribusiness Management, Bihar Agriculture University, Sabour, Bhagalpur, Bihar, India
*Corresponding Author's email: shubham6683@gmail.com

Block chain technology is becoming a game-changing instrument in agriculture as global food supply chains grow and consumers want more information. This analysis looks at how block chain may be used to improve traceability, transparency, food safety, fair trade, and reduce fraud in agricultural value chains. It talks about the basics of blockchain, how it is used now, its main benefits, examples of how it is used in the real world, and its limits. The article looks at how blockchain could change agri-food systems for the better by using recent academic research and international case studies. It also talks about the things that need to be done at the policy and practical levels for blockchain to be used successfully.

Introduction

Agriculture is the backbone of the world's food system, but it has problems that won't go away, such supply chains that don't work well, a lack of transparency, food fraud, and unfair trade practices. It's not always easy to get accurate information about where a product comes from, how it got there, and what circumstances it was in. Blockchain is a decentralized, tamper-proof ledger system that might help with these problems by allowing records that can't be changed, tracking in real time, and trust without middlemen (Casino et al., 2019). Blockchain is being looked into more and more as agriculture becomes more digital to make sure that food supply networks are open and accountable.

Understanding Blockchain Technology

Blockchain is a safe and reliable way to record transactions on a distributed ledger. There is a "chain" of data blocks since each transaction is connected to the one before it using cryptography (Nakamoto, 2008). It may be either public or private, and it lets you use smart contracts, which automatically carry out the terms of an agreement when specific criteria are satisfied.

Key Features

- **Decentralization**: Eliminates reliance on a single authority.
- **Immutability**: Data cannot be altered once added.
- **Transparency**: All participants have access to the same data.
- **Smart Contracts**: Facilitate automated transactions based on pre-set rules.

The Need for Blockchain in Agriculture

Global Food Supply Chain Challenges

Food supply chains often involve multiple intermediaries across countries, making them opaque and prone to fraud, mislabeling, spoilage, and inefficiencies (Galvez et al., 2018). Consumers, particularly in high-income countries, are demanding more information about food origins and ethical production.

Gaps in Current Systems

- Lack of **real-time traceability**

- **Fragmented** data sharing across actors
- **Manual** and error-prone documentation
- Risk of **food contamination** and **counterfeit products**

Applications of Blockchain in Agricultural Supply Chains

End-to-End Traceability

Blockchain enables each actor—from farmer to retailer—to input data into a shared ledger. This allows products to be traced in real-time from farm to fork.

Example: IBM's Food Trust platform tracks lettuce, spinach, and mangoes from farms in the U.S. to retail shelves in minutes, reducing recall times drastically (IBM, 2020).

Quality Assurance and Food Safety

Sensor data (e.g., temperature, humidity) from cold chains can be recorded on the blockchain, verifying product integrity.

Example: TE-FOOD, a Vietnamese initiative, allows users to scan a QR code on pork to view its journey and test results (Kamilaris et al., 2019).

Certification and Compliance

Blockchain supports transparent certifications like organic, non-GMO, Halal, or Fairtrade. It reduces fraud and increases consumer trust.

Example: Bext360 works with coffee farmers in Africa to document fair pricing and ethical sourcing, shared directly with buyers (Tripoli & Schmidhuber, 2018).

Payments and Financing

Blockchain can facilitate secure, instant cross-border payments to smallholders and offer credit scoring based on immutable records.

Example: AgUnity enables farmers in Kenya and Papua New Guinea to manage produce sales, input purchases, and receive mobile payments using a blockchain-based app (Rejeb et al., 2021).

Benefits of Blockchain in Agriculture

Benefit	Impact
Transparency	All supply chain stakeholders access the same verified data
Food Safety	Real-time tracking aids in faster recalls and reduces contamination
Consumer Trust	Buyers can verify source, quality, and ethics of products
Fraud Prevention	Tamper-proof records deter mislabeling and substitution
Supply Chain Efficiency	Reduced paperwork, fewer disputes, and faster payments
Smallholder Empowerment	Fair pricing, better market access, and verifiable transaction histories

Blockchain for Fair Trade and Farmer Inclusion

Blockchain can democratize agriculture by removing intermediaries and giving farmers direct access to markets. It promotes ethical sourcing by offering proof of origin and fair pricing mechanisms.

Ensuring Fair Trade: Producers can verify minimum pricing agreements via smart contracts. Consumers can see exactly how much of their money reaches the farmer.

Empowering Smallholders

- Smart contracts automate pricing and delivery conditions.
- Verifiable records build farmer credibility for loans and certifications.
- Mobile-based blockchain apps bring the technology within reach of the rural poor.

Real-World Case Studies

Provenance in the UK Provenance uses blockchain to verify and communicate ethical practices of artisanal producers. In one pilot, Indonesian tuna fishermen logged catch details to prevent illegal fishing (Provenance, 2020).

Ambrosus: This Swiss company combines IoT sensors and blockchain to track milk and pharmaceutical supply chains, enhancing data integrity and regulatory compliance (Ambrosus, 2020).

India's Coffee Board Pilot: India's Coffee Board launched a blockchain-based e-marketplace for traceable coffee where consumers can scan a code to access farm-level information (Coffee Board of India, 2019).

Challenges and Limitations

Challenge	Explanation
Technological Complexity	Requires digital literacy and stable internet
Cost of Implementation	Sensors, software, and training are expensive
Data Integrity	"Garbage in, garbage out"—initial data must be accurate
Interoperability	Systems must connect with existing infrastructure
Scalability	Difficult to apply in fragmented, informal agricultural markets

Legal and Ethical Issues

- Data ownership and privacy concerns
- Regulatory uncertainty in many countries
- Need for standardization across platforms

Policy Support and Infrastructure Needs

Governments can accelerate adoption by:

- Funding pilot projects and farmer training
- Creating regulatory sandboxes for innovation
- Investing in rural digital infrastructure
- Collaborating with private tech providers

The Future of Blockchain in Agriculture

Integration with Other Technologies

- **IoT** sensors feeding real-time data into the blockchain
- **AI** for predictive analytics in crop supply and demand
- **Satellite data** to verify geolocation of farms and deforestation-free supply chains

Carbon Credits and Sustainability

Blockchain can record carbon sequestration data for regenerative agriculture, enabling transparent carbon markets and climate-smart farming incentives.

Decentralized Marketplaces

Direct farmer-to-consumer blockchain-based platforms may emerge, reducing transaction fees and improving inclusivity.

Conclusion

Blockchain offers transformative potential in agriculture, enabling transparent, traceable, and fair supply chains. It not only improves food safety and efficiency but also empowers farmers and earns consumer trust. However, realizing this promise requires addressing technological, infrastructural, and regulatory challenges. With appropriate support and innovation, blockchain can play a critical role in shaping sustainable and equitable food systems for the future.

References

1. Ambrosus. (2020). *Secure supply chains using blockchain and IoT*. Retrieved from https://ambrosus.io
2. Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telecommunications Systems*, 71(1), 145–158.
3. Coffee Board of India. (2019). *Blockchain-based marketplace for Indian coffee*. Retrieved from http://indiacoffee.org

4. European Commission. (2022). *EU Blockchain Observatory and Forum*. Retrieved from https://ec.europa.eu
5. Galvez, J. F., Mejuto, J. C., & Simal-Gandara, J. (2018). Future challenges on the use of blockchain for food traceability analysis. *Trends in Analytical Chemistry*, 107, 222–232.
6. IBM. (2020). *IBM Food Trust: Trust and transparency in the food supply*. Retrieved from https://www.ibm.com/blockchain/solutions/food-trust
7. Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science & Technology*, 91, 640–652.
8. Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Retrieved from https://bitcoin.org/bitcoin.pdf
9. Provenance. (2020). *Blockchain-enabled supply chain transparency*. Retrieved from https://www.provenance.org
10. Tripoli, M., & Schmidhuber, J. (2018). *Emerging opportunities for the application of blockchain in the agri-food industry*. FAO and ITC Joint Report.