NEW ERA AGRICULTURE MAGAZINE

Block Chain Technology in the Agri-Food Supply Chain

CH. Arundhathi[1], S. Ganesamoorthi[2], G. Sowmya[3]

Introduction:

Industry 4.0, also known as I4.0, is a constantly evolving field of technology trends that enterprises use at various levels and in various capacities to improve current processes and gain a competitive position in the market. Although many I4.0 technologies have yet to be fully implemented, they are expected to play an important role in the near future. One of these is blockchain technology, often known as BCT. Originally, BCT is a mechanism for trading and tracing financial assets, however it gained prominence as a platform for managing the digital currency Bitcoin. However, the notion of BCT has evolved, and it now adds value to industries such as manufacturing, international insurance, marketing, and supply chain management.

Global agri-food SCs (Supply Chains) would unavoidably be affected by regulatory approvals like the Food Safety Modernization Act (FSMA 2011) and HACCP (Hazard Analysis and Critical Control Points), which enforce hazard analysis, strong record keeping methods, and openness.

Consumers increasingly place a larger priority on food quality and safety standards due to changing lifestyles and higher disposable incomes in many parts of the world. They are expecting information on where and how their food is obtained, manufactured, and delivered in a transparent, safe, and sustainable manner in addition to regulatory compliance. Unfavorable incidents involving food safety or health risks could severely damage the value of the corporate brand and erode consumer trust, leading to lawsuits and product recalls.

This growing consumer demand has been shown to influence the likelihood of BCT adoption in the agri-food business. As a result of global difficulties, stakeholders' demands for a more sustainable future are rising in addition to those of consumers. The United Nations Sustainable Development Goals, particularly Goal 2 Zero Hunger and Goal 12 Responsible Production and Consumption, are pushing the demand for improved traceability and transparency in global food supply chains. For the agri-food business, BCT is both innovative and hopeful, since it allows it to

CH. Arundhathi (Teaching Associate) Agricultural Extension,
G. Sowmya (Teaching Associate) Agricultural Economics,
MJPTBCWREIS, B. Sc. (Hons.) Agricultural College, Karimnagar, Telangana, India
S. Ganesamoorthi (Associate Professor) Department of Agricultural Extension,
University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

overcome its present supply chain difficulties. Academics and professionals believe that blockchain technology can improve agri-food SCs and potentially change current processes in order to solve these issues. However, BCT implementation in SCM is restricted.

Food Supply Chain

Farmers, shipping companies, wholesalers and retailers, distributors, and grocery stores are just a few of the many different actors that make up the global food chain. Following is a list of the key stages that make up a typical agri-food supply chain (Caro, Ali, et al. 2018):

1. *Production*: The farm's entire range of agricultural operations are included in the production phase. To raise crops and cattle, the farmer uses organic materials (fertilizers, seeds, animal breeds and feeds). We may have one or several harvests or yields throughout the course of the year, depending on the cycles of the cultivations and/or animal production.
2. *Processing*: This phase is concerned with the entire or partial transformation of a primary product into one or more secondary products. Following that, a packaging step is anticipated, during which each package may be individually identifiable by a production batch code containing information such as the production day and a list of raw materials utilized.
3. *Distribution*: The product is ready for distribution after it has been packaged and labeled. Depending on the product, delivery times could be restricted to a specific range and a product storage stage might be included (Storage).
4. *Retailing*: At the end of the distribution, the products are delivered to retailers who perform the sale of the product (Retailers). The end-user of the chain will be the customer, who will purchase the product (Customer).
5. *Consumption*: The consumer is the end user of the chain, he or she purchases the product and expects traceable information on quality standards, country of origin, manufacturing procedures, and so on.

Blockchain in Agriculture and Food Supply Chain

Agriculture and food supply chains are well interlinked, since the products of agriculture almost always are used as inputs in some multi-actor distributed supply chain, where the consumer is usually the final client. Figure 1 depicts a simplified example of food supply chain digitization enabled by blockchain technology. The digital flow layer (middle layer) exists beneath the physical flow layer (top layer), and it consists of numerous digital technologies (such as QR codes, RFID,

NFC, online certification and digital signatures, sensors and actuators, mobile phones, and so on). The Internet/Web acts as the infrastructure for communication. Every action completed along the food chain is recorded to the blockchain (bottom layer of Figure 1), which serves as an immutable way of storing information that is approved by all participating parties. Four primary attributes of blockchain which act as significant enablers for transparency, namely traceability, immutability, auditability and provenance. These attributes were considered relevant within the domain of agri-food SCs.

The information gathered during each transaction is validated by the food supply network's business partners, generating a consensus among all participants. Each validated block is added to the chain of transactions (as seen in Figure 1), creating a permanent record of the entire process. Different technologies are used and different information is written to the blockchain at each point of the food trajectory (identified with numbers 1-6 in Figure 1), as outlined below for each of these stages:

1. Provider: Information about the crops, pesticide and fertilizers used, machinery involved etc. The transactions with the producer/farmer are recorded.
2. Producer: Information about the farm and the farming practices employed. Additional info about the crop cultivation process, weather conditions, or animals and their welfare is also possible to be added.
3. Processing: Information about the factory and its equipment, the processing methods used, batch numbers etc. The financial transactions that take place with the producers and also with the distributors are recorded too.
4. Distribution: Shipping details, trajectories followed, storage conditions (e.g. temperature, humidity), time in transit at every transport method etc. All transactions between the distributors and also with the final recipients (i.e. retailers) are written on the blockchain.
5. Retailer: Detailed information about each food item, its current quality and quantity, expiration dates, storage conditions and time spent on the shelf are listed on the chain.
6. Consumer: At the final stage, the consumer can use a mobile phone connected to the Internet/Web or a web application in order to scan a QR code associated with some food item, and see in detail all information associated with the product like food security, food safety, food integrity, support of small farmers, waste reduction and environmental awareness and better supervision and management of the supply

chain from the producer and provider till the retail store.

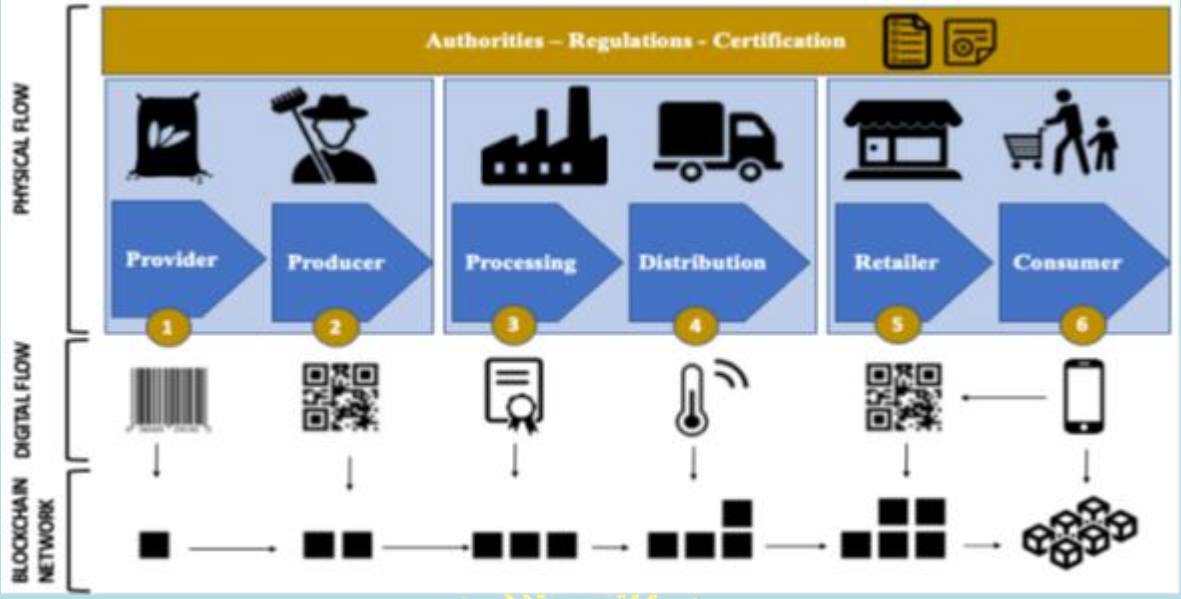

Fig 1: Food Supply Chain System

The concept of smart contracts, which refers to computer protocols that allow a contractual agreement to be automatically implemented or enforced when a specified set of criteria and circumstances are met, is a core feature of blockchain technology. Once this occurs, payment terms are accepted and processed for all parties involved. The smart contract considers information provided by upstream and downstream SC members who have registered on the blockchain. Businesses can increase traceability and gather auditable product histories with the help of this information flow. Retailers can also track the location and condition of shipments. Producers and processors can better monitor storage conditions. Consumers can gain more insight into the movement of different food products from farm to fork.

CONCLUSION

Blockchain is a potential technology for a transparent food supply chain, but many constraints and challenges remain, limiting its wider adoption among farmers and food supply networks. Blockchain are particularly important from an environmental sustainability perspective, by transparent monitoring of raw material usage, energy consumption and emissions during production, product lifecycle visibility in SCs, reduction in operational costs and waste generation due to costly product recalls, thereby increasing efficiency Various actions can be taken, such as encouraging the growth of blockchain-minded ecosystems in agri-food chains, supporting the technology as part of the general goals of optimizing the

competitiveness and ensuring the sustainability of the agri-food supply chain, as well as designing a clear regulatory framework for blockchain implementations. It will be fascinating to see how blockchain will be integrated with other new technologies (big data, robots, IoT, RFID, NFC, hyperspectral imaging, and so on) to achieve more automation of food supply systems while maintaining full transparency and traceability.

REFERENCES

1. Caro, M.P., M.S. Ali, M. Vecchio, and R. Giaffreda. 2018. "Blockchain-based traceability in Agri-Food supply chain management: A practical implementation." *IoT Vertical and Topical Summit on Agriculture-Tuscany (IOT Tuscany).* IEEE. 1-4.
2. Xu, Xiwei, Qinghua Lu, Yue Liu, Liming Zhu, Haonan Yao, and Athanasios V. Vasilakos. 2019. "Designing blockchain-based applications a case study for imported product traceability." *Future Generation Computer Systems.* **92**: 399-406.
3. Hooper, A., & Holtbrugge, D. 2020. Blockchain technology in international business:changing the agenda for global governance. *Review of International Business and Strategy, **30*** (2), 183–200.
4. Haddud, A., & Khare, A. 2020. Digitalizing supply chains potential benefits and impact on lean operations. *International Journal of Lean Six Sigma*, ***11***(4), 731–765.
5. Hughes, L., Dwivedi, Y., Misra, S., Rana, N., Raghavan, V., & Akella, V. 2019. Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management, **49***:114–129.
6. Bumblauskas, D., Mann, A., Dugan, B., & Rittmer, J. 2020. A blockchain use case in food distribution: Do you know where your food has been? *International Journal of Information Management.* **52**, 102008.