The Old "Block" and Chain: How Farm Data Will Be Used on the Blockchain

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Abstract
Blockchain technology is rapidly becoming a household word and promises to help solve issues related to information management. This article contributes to the understanding BCT in the agrifood system and how the technology provides one version of the truth so trade can be trusted, traceable, and transparent.

Introduction

If you believe the latest hype about technology, you'd think that blockchain technology (BCT) is going to transform every business by next Wednesday. Of course, that's not the case, but the agrifood system seems custom-designed for the technology. More and more food products and beverages are branded and accompanied by a variety of certification schemes. For instance, organic production is concerned with verifying sustainable practices. Unlike high oleic acid soybeans or other products with measurable differences, there is no chemical test to determine whether the product was produced under organic or conventional practices. Without verifiable and data rich assets, unqualified counterfeit products with high-quality labels or claims, move across supply chains. The agrifood system has a number of information management problems, mostly concerning the recording of documents that are important to the transfer of information, product, and funds (e.g., certifications, transport orders, bills of lading, pallets, lot numbers, etc.). It includes a large number of firms and farms involved in growing crops, transforming crops into food ingredients, converting products from food ingredients, packaging, shipping, selling and consuming food products (Kinsey 2010). Envision an agrifood system, with all of its legacy technologies, but operating as a common database, a backbone, that all participants in an industry (or a supply chain) can access, read and write to, then all past frustrations with the absence of interoperability can be overcome (Korpela 2017). BCT seems to be a logical choice for verifying practices with verified data.

BCT alone does not solve the farm data challenges or the need for digital agricultural technology, but it can be a powerful prompt for new ways of working, enabling greater accountability when implemented effectively. Often referred to as a new general-purpose technology puts BCT in the same class of technological trajectories, for instance, electricity, transistors, computers, the internet, mobile phones, and so on (Schumpeter,1942; Perez 2009). Just as smart phones and mobile media are a 'next generation' from personal computers, blockchains have been represented as the next generation of the internet (Swan 2015, Tapscott 2016). The technology itself is typically an open-source computing platform that provides consensus and gives financiers, growers, and traders single truth view of the commodity valued at real time (Ge, 2018). Despite its popularity and the great interests it has received, the technology is still far from being well understood. Farmers and food processors often ask questions related to how it works and what does it cost. This article explains how BCT would work mainly from the perspectives of the farmer, elevator, and grain miller in the agrifood supply chain.

BCT – The Value Proposition

Much of agrifood system's compliance data and information are certified by trusted third parties and stored either on paper or in a centralized database and these approaches are known to suffer from many informational problems such as the high cost and inefficiency of paper-based processes and fraud, corruption and error both on paper and in IT systems (Tian 2018).

A blockchain—is a type of distributed ledger technology (DLT)— meaning it is a data ledger that is shared by multiple entities operating on a distributed network (Davidson 2018). Its value proposition is similar to 'social technologies' that improves efficiency by coordinating people, organizations, and institutions. For instance, it minimizes the supply chain's cost of verifying the three T's: trust, transparency, and traceability. Trust refers to a system that ensures consistency of information on labels and advertisements. That is, it refers to the authenticity of data or certificate. Counterfeits have caused both financial loss and may even damage company's brand reputation. Transparency refers to whether the product claims are valid. That is, are product claims such as diet (e.g., low fat) fairness to animals (e.g., cage free, grass fed), and purity, good for the environment fertilizer was applied (e.g., non-gmo). Traceability involves tracking products end-to-end in the supply chain. That is, where the product was sourced, and providing tracking information to consumers (e.g., when products change identifiers or possession, are repackaged or crossed borders when both naming and labeling methods vary).

The Blockchain Digital Architecture

Blockchain is not a single technology. It is a part of a larger digital architecture that ensures the information that is recorded truly represents the state of the physical commodity. The data sent to the blockchain comes from the traditional agricultural applications from farm data, such as Big Data, Global Navigation Satellite System, and Artificial Intelligence algorithms for analysis and IoT (Internet of Things), which describes the connection of devices — any devices — to the internet using embedded software and sensors to communicate, collect and exchange data with one another. BCT require clean, accurate, trusted, verifiable data. Much of this farm data will been cleaned with publicly available tools e.g. USDA ARS Yield Editor for yield monitor. Without data integrity "analysts are concerned with the veracity of the upstream and downstream transactions" (Griffin et al. 2019). For food processors the information sent to the blockchain come from the legacy ERP (Enterprise Resource Planning) systems including ASNs (Advance Shipping Notices) and EPCIS events (Electronic Product Code Information Services, a global GS1 Standard for creating and sharing visibility event data).

Although blockchain can be used to create trustworthy digital assets, buyers and sellers need to be sure it represents what is happening in the physical world. Building a robust digital infrastructure is critical to providing certificates. The fundamental principles concerning verification requires a distributed ledger, proof of work, digital signatures, and a consensus algorithm. Some blockchain platforms are private and require permission to join, while others are un-permissioned. Blockchain platforms, such as Ethereum, Hyperledger (a collaboration of IBM, Intel and others), Agridigital, and Ambrosus are involved in cases involving tuna, beef, grains, mangoes, and shipping containers (Ge et al. 2017).

The Purchase and Sale of Commodities on a Blockchain

One of the most significant obstacles for BCT applied to agricultural commodities is that some farm production, such as grain, is amalgamated and mixed at the storage and shipping stages. Let us say a corn miller deploys a blockchain and each stakeholder on the supply chain owns a full copy of the transaction data. How might it function? In the following representation, a blockchain operation is conceptualized between the farmer, elevator and the miller:

Farmer to the Elevator:
Corn is produced on a farm in Central Kansas. The process first starts at the time of harvest. Farmers store in the blockchain details about the harvest. For example, certifying that the process from seeding (or earlier) to harvesting is compliant with certain regulations (e.g., organic, non-gmo, nutrient management plans, etc.), which consequently needs a certification authority, and frequently site-specific yield estimates (e.g., USDA's Yield Editor for data quality assurance) to confirm this is the case. This certification authority issues signing authority of a certificate analysis to the farm, enabling the farm to certify specific identified portions of the crop (lots). The lots are identified using a unique identification number (e.g., a barcode). Also, the producer's identity is stored on the blockchain. After certifying these lots, they are shipped to a grain elevator. The farmer's delivery would move across the weighbridge and testing the quality of the grain at the sample station. This information will be used to generate a certificate of analysis. At the moment of taring off at the weighbridge, the settlement is recorded onto the blockchain. The farmer transfers the ownership of the corn to elevators, directly through the blockchain.

A settlement of the transaction between the farmer and elevator depends on a network of computers that usually provide the computing power to achieve consensus for example by 'mining' if is achieved by 'proof of work'. This is an intensely complex algorithm that requires a significant amount of computing resources to solve.

The Elevator
The grain buyer at the elevator is responsible at the first point of sale for determining whether they are introducing the advertised product into the supply chain. All the grains received at this elevator pass through the quality control procedure before being stored in silos. The quality control process allows the segregation of grains by levels of quality so that prices are set according to the characteristics of the stored and marketed corn. When grain corn is received and processed by purchase order, a batch number is used on the actual transaction. The batch number is assigned attributes. These could be an identity preserved certification, Global Location Number (GLN) or growth location. It can be taken and written to the blockchain as the origin information. Also, the producer's identity is stored on the blockchain. When product is shipped to the elevator, transaction between manufacturer and elevator will occur. First the elevator checks ownership of the product via the blockchain platform to ensure what he received is

not counterfeited. Then the message indicating the product was checked and received will be sent to the blockchain and the ownership of corn is transferred from elevator to manufacturer. The transaction information is broadcasted to every node in Ethereum for further blockchain mining.

Elevator to the Miller

When the corn is shipped to the miller, a transaction between the elevator and miller will occur. First an elevator checks product's ownership via blockchain platform to ensure what was received meets the quality claims of the sold product. Then a message will be sent to the blockchain indicating the product is checked and received. The ownership of corn is transferred from elevator to the miller (Davidson et al., 2018).

The next step is the corn processing or packaging. To convert the corn from a commodity to a value-added product, a production order is used to turn a bulk order into a packaged finished item. It could be a 25-pound bag of milled corn. The milled corn gets another batch number, which provides an opportunity to record additional attribute information. For example, the condition, temperature, nutritional, packaging supplier information (traceability) or anything pertinent to the product written can be written to the block chain as quality control information.

The Transactions

The farmer, elevator, and miller are able to verify the validity of the certificate issued by querying the blockchain. Likewise, other downstream stakeholders (e.g. banks, transporters, customers, etc.) are able to do the same. When the corn changes ownership, this is recorded in the blockchain, as well and this enables anyone to check the provenance chain of the corn. If the farm uses some kind of unauthorized pesticide, and this is discovered during an audit, then the auditor is able to revoke any certificate issued by the farm (Lucena et al 2018). This is recorded on the blockchain so anybody validating the certificate is able to see this.

Conclusion

In summary, blockchain can provide a version of truth so trade can be trusted, traceable, and transparent within the agrifood system. Technological advancement along the supply chain is seldom neutral. BCT will be no exception. Similar to other network wide technologies (e.g. Precision Farming), BCT may lower the cost of verification by replacing human verified practices with verified data. The technology will create different opportunities and challenges for different farm-to-fork stakeholders, depending on their current position in the market and in the value chain of food information. For users and organizations to adopt the technology and form new ways of working, opportunities to decrease the uncertainty of farm data will increase the value of certificates due to the improved transparency and reliability of certificates, and lower transaction costs due to trust in information.

References

Davidson, S., De Filippi, P. and Potts, J. (2018). *Blockchains and the economic institutions of capitalism.* Journal of Institutional Economics, vol. 14, no. 4, pp. 639-658.

Ge, Lan, Christopher Brewster, Jacco Spek, Anton Smeenk, and Jan Top, (2017). Blockchain for Agriculture and Food; Findings from the pilot study. Wageningen, Wageningen Economic Research, Report 2017-112. 34 pp.; 4 fig.; 2 tab.; 18 ref.

Griffin, T.W., Harris K. and Ward, J. (2019). Enhancing Farm Data Value with Blockchain PrecisionAg Institute. July 3, 2019. https://www.precisionag.com/digital-farming/data-management/enhancing-farm-data-value-with-blockchain/

Kinsey, J. D. (2001). The new food economy: consumers, farms, pharms, and science. *American Journal of Agricultural Economics*, *83*(5), 1113-1130.

Korpela, K., J. Hallikas, and T. Dahlberg (2017). Digital Supply Chain Transformation toward Blockchain Integration. In Hawaii International Conference on System Sciences (HICSS) 2017. https://doi.org/10.24251/HICSS.2017.506

Lin, J. Z. Shen, C. Miao, A. Zhang, and Y. Chai. (2018). Blockchain and IoT based Food Traceability for Smart Agriculture. In Proceedings of 3rd International Conference on Crowd Science and Engineering, Singapore, July 2018 (ICCSE'18), 6 pages. https://doi.org/10.1145/3126973.3126980

Lucena, P., Binotto, A. P., Momo, F. D. S., & Kim, H. (2018). A case study for grain quality assurance tracking based on a Blockchain business network. *arXiv preprint arXiv:1803.07877*.

Schumpeter, J. (1942). Creative destruction. *Capitalism, socialism and democracy*, *825*, 82-85.

Swan, M. (2015). *Blockchain: Blueprint for a New Economy*. O'Reilly Media, Inc.

Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution: how the technology behind bitcoin is changing money, business, and the world*. Penguin.

Tian, F. (2018). *An information System for Food Safety Monitoring in Supply Chains based on HACCP, Blockchain and Internet of Things.* Doctoral thesis, WU Vienna University of Economics and Business.