FUTURE TECHNOLOGIES: BLOCKCHAIN TECHNOLOGY APPLICATIONS IN THE WYOMING FOOD SYSTEM

Cole Ehmke and Dr. Mariah Ehmke
Department of Agricultural and Applied Economics
University of Wyoming

Corresponding author:

Cole Ehmke
Department of Agricultural and Applied Economics
Dept. 3354, 1000 E. University Ave.
Laramie, WY 82071 USA
cehmke@uwyo.edu, (307)766-3782

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Abstract

Blockchain is emerging as a new tool agricultural producers, supply chain managers, food suppliers, and retailers may use to coordinate supply networks, facilitate financing, and provide customers with product information. Blockchain provides a decentralized, immutable, and secure verification system for food and agricultural products, from local farms to the global table. The objective of this work is to trace the potential role of blockchain in Wyoming agricultural products and marketing options. While the applications are in the early stages of development, we find that farms or ranches may benefit from a thorough understanding of this technology. Recent changes in Wyoming state law facilitate the development of blockchain. This paper describes the technology, reviews applications within the food system, describes state law changes, and identifies considerations associated with the technology for advisors.

Keywords: blockchain, supply chain, technology, traceability, provenance, marketing

Introduction

In early 2018 the Wyoming Legislature answered a global need for legal codes and compliance – defining cryptocurrencies and providing a supportive environment in which blockchain accounting-based businesses may operate. The legislation provided momentum for Wyoming-based blockchain businesses to apply the technology to agricultural products, including beef and lamb (Wyoming State Legislature, 2018). Producers and blockchain businesses see opportunity to provide irrefutable provenance or source verification for products such as beef which are often blended without source verification to national or out-of-state supply chains.

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The distributed ledger technology (akin to a universal Excel spreadsheet) known as blockchain emerged in 2008 when described by Satoshi Nakamoto in his paper *Bitcoin: A Peer-to-Peer Electronic Cash System*, which laid out the mathematical foundation for cryptocurrencies. Nakamoto described a peer-to-peer version of electronic banking that would allow transfers between parties without the need for a financial institution or a trusted third party. He noted that services provided by intermediaries added costs, and proposed an electronic system in which ownership could be proven through a record of transactions protected by cryptography and distributed amongst peers – no intermediary would be needed (Nakamoto, 2008). Blockchain is the foundational technology of this electronic system. The concepts of transactions, hashes, private keys, digital signatures, timestamp servers, proof-of-work, and nodes of blockchain were then used to create the cryptocurrency Bitcoin – the first digital currency created and exchanged independently of banks and governments. But let us be clear, we are writing about blockchain technology, not Bitcoin.

Blockchain technology has emerged as a way to conduct transactions within business networks, and enterprises may use it for financial records, asset management, and supply chain management. Blockchain opens the door to new applications such as smart contracts. Here, we describe how financial management, supply chain management, and smart contracts may work within blockchain agriculture.

What is Blockchain?

In the simplest terms, a blockchain is a digital encryption and recording of the history of transactions leading to the current asset state or value. The primary problem that Nakamoto[1] solved with blockchain relates to trust establishment among an anonymous group of individuals by using a common digital history. Nakamoto's aim was to track property ownership so that double spending (buying something that has already been sold) would be prohibited.

Consider how financial transactions occur. A real estate transaction is a common example. If someone wanted to sell a house, using conventional methods in the US, at what point do we know there was commitment to the deal? A contract would be developed with the

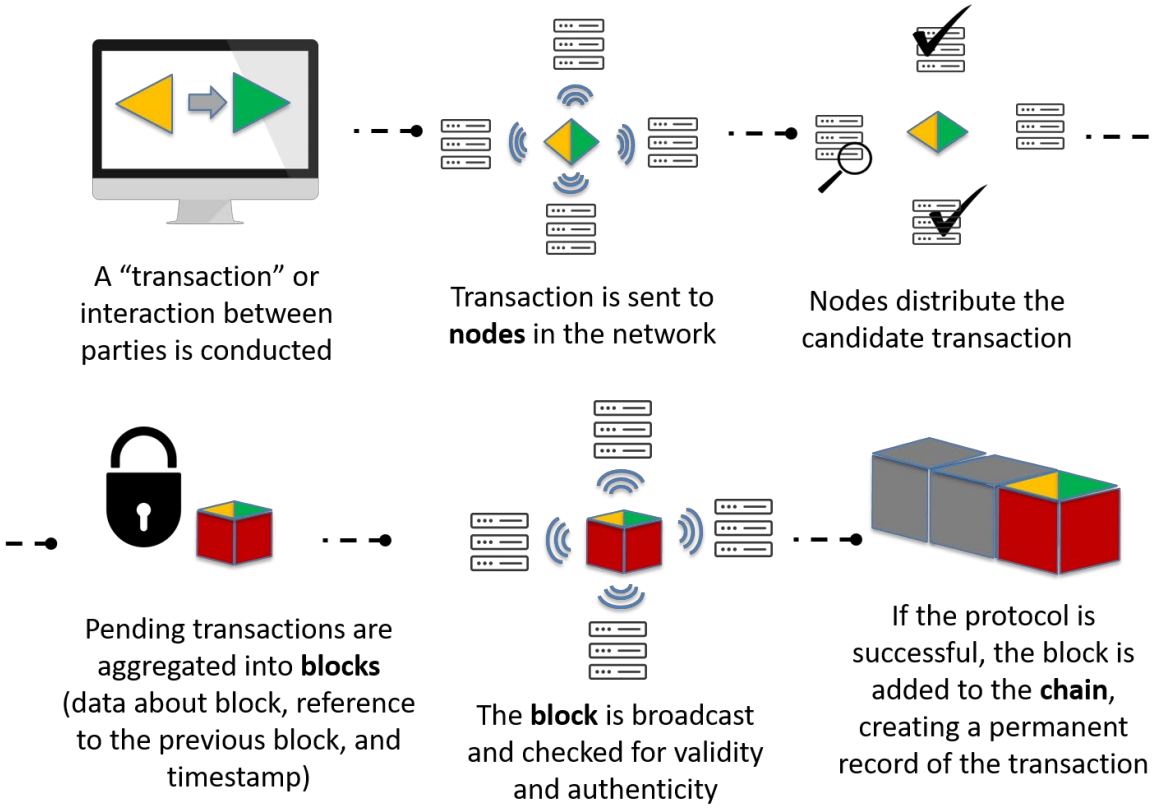
[1] The Satoshi Nakamoto name is a pseudonym and the author's true identity is unknown.

buyer, and they would record the deal in a public registry of deeds. The seller's true ownership would be verified from the record of all the ownership transactions of the house, a paper trail kept by title companies. Thus financial institutions require a title search and the purchase of title insurance to protect the buyer and seller. Through this process, ownership is verified and frauds get detected (selling a house one doesn't own, or selling the property to more than one person).

Likewise the current status problem arises in financial transactions. For instance, an account held by an individual at a bank. If there should be a discrepancy in the balance, it is assumed that the bank's records are correct as the trusted holder of the authoritative ledger. The individual must prove that the bank's records are not correct. Overall, the current systems have worked very well. However, they require trust in the ledger's administrator and cannot be scaled to large number of frequent transactions.

The blockchain option provides a distributed trust mechanism: multiple parties keep a record of transactions, and each party within the peer-to-peer network can verify that the information is tamper free. Figure 1 illustrates the process. Say that two parties in a blockchain network wish to engage in a transaction – perhaps add a transfer of ownership to their ledger. The individuals in the network are called *nodes*. A node sends the information for the transaction to his peer nodes, and it is verified as coming from a permitted source. Then numerous transactions are aggregated into a "block" and submitted to the network for verification. Valid and authentic blocks are approved and digitally encrypted for storage. The format for the digital code of a block contains a *block header* with metadata about the block, and *block data* containing a set of transactions and other related data. Every block header (except for the very first block of the blockchain) contains a cryptographic link to the previous block's header, a timestamp, and information about the block. The blocks are thus linked to form a chain. The mechanism used to link them is an encrypted *hash function* – a mathematical process that takes an input and calculates exactly one output. When a new record is inserted into a blockchain, the last computed hash is broadcast. Because everyone knows the last hash, anyone can verify that the data hasn't been altered, since altering the data would mean that a new – and invalid – hash was used.

Figure 1. The blockchain process



The rules used for verification are the *consensus* mechanisms agreed upon for the network. Each blockchain application defines its own data fields for block data – the details expected for a real estate transaction, for instance. The whole blockchain (all of the digital events that have been executed and shared among participating parties) is stored on multiple distributed computers (though not necessarily every member's computer). It is computationally extremely hard to alter transactions or introduce false transactions because it is secured cryptographically (the blockchain is tamper resistant), plus it is tamper evident since the linked nature of the blocks would indicate any attempt to modify them. Hash functions are such that if an entity were to modify even one character of the computer code containing the block, a different output would be created which would not match any of the information held by the other nodes – thus tampering is obvious. Some refer to blockchain is "stone tablets in the sky" for their near irreversibility. The reliance on a distributed network of computers avoids a single point of failure. Distributed trust in the blockchain also enables participants to all be in agreement on valid transactions.

In sum, blockchain has features that set it apart from a traditional digital ledger or relational database, which Gargolinski Jaeger (2018) describes this way:

- Blockchains are **distributed** across and managed by peer-to-peer networks of computing devices.
- Transaction data is **shared** among participants of the blockchain network, which eliminates the need to reconcile disparate ledgers.
- A transaction is added to the blockchain only after it has been validated through a **consensus** mechanism that ensures it is the one and only version of the truth.
- The data is **immutable** because each transaction is cryptographically secured and linked to the previous transaction as it is recorded.
- An asset on a blockchain has **provenance** because participants can see where it came from and how ownership of it has changed over time.

Blockchain Applications in Agriculture

The issue of retracing ownership becomes more of a hurdle over a longer chain of changing buyers in global financial transaction services, or for physical goods, *e.g.,* (blood) diamonds or broccoli. Because a transaction is basically a string of electronic code, it can contain arbitrary information. Thus blockchain technology can be used for any kind of notarization, and not necessarily involving money. For instance, Walmart, with more than 260 million customers per week, may be very interested in a technology that helps to identify precisely which batches of vegetables are, for instance, infected with E. coli bacteria. It has already told suppliers of leafy greens to use a blockchain-based tracking system built in collaboration with IBM by September 2019 (De, 2018).

Advocates say that blockchain technology has the potential to make the food supply chain more secure, transparent and efficient. For instance, it could be deployed to track physical products and verify attributes from origin to the point of sale – allowing one to trace the origin of a product or produce (provenance) and track a product/produce during its journey in a supply chain. The transparency would be provided through the updates those in the chain receive.

For many on the production side of the agricultural supply chain, there is the potential of the reduction or elimination of intermediaries (middlemen) and perhaps improved pricing and decreased transaction fees.

Amen and Ehmke (2018) point out some applications within agriculture:

- **Food traceability**. The Blockchain Food Safety Alliance (created in late 2017) tested the traceability of perishable food products from farm to store in just a few seconds. It is a collaboration of IBM, Walmart, Chinese retailer JD.com, and Tsinghua University National Engineering Laboratory for E-Commerce Technologies.
- **Tracking commodities**. Recent food fraud scandals have involved blending wood pulp with cheese in the US and marketing horse meat as beef in Europe. A blockchain combined with DNA testing might reduce issues in food fraud such as diversion, theft, tax evasion, misuse, and adulteration. Such traceability might also be of interest to consumers interested in the provenance of the food they buy.
- **Grain trading**. A shipment of US soybeans in early 2018 was completed in which the sales contract, letter of credit, and certificates were digitized on the Easy Trading Connect (ETC) platform – the transaction time was cut in half (to a week).

A more general application of blockchain could be a *smart contract*. Smart contracts are scripts stored on the blockchain. Blockchains can encrypt and store data securely, and restrict access to data to only desired parties, which would be an advantage. But more than that they can then be programmed to utilize the data within a self-executing logical flow of operations. For instance, you could store a promise to do something at a later time, with the promise stored in the form of code that would execute in an automated manner once certain conditions are met. Zaninotto provides an example:

> Imagine that you want to rent your house for a week [for] $1,000, with a 50% upfront payment. You and the loaner sign a contract, probably written by a lawyer. You also need a bank to receive the payment. At the beginning of the week, you ask for a $5,000 deposit; the loaner writes a check for it. At the end of the week, the loaner refuses to pay the remaining 50%. You also realize that they broke a window, and that the deposit check refers to an empty account. You'll need a lawyer to help you enforce the rental contract in a court.
>
> Smart contracts in a blockchain allow you to get rid of the bank, the lawyer, and the court. Just write a program that defines how much money should be transferred in response to certain conditions:

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- two weeks before beginning of rental: transfer $500 from loaner to owner
- cancellation by the owner: transfer $500 from owner to loaner
- end of the rental period: transfer $500 from loaner to owner
- proof of physical degradation after the rental period: transfer $5,000 from loaner to owner

Upload this smart contract to the blockchain, and you're all set. At the time defined in the contract, the money transfers will occur. And if the owner can bring a predefined proof of physical degradation, they get the $5,000 automatically (without any need for a deposit).

Where might we get a proof of physical degradation? In order to interact with the real world, blockchains need sensors and actuators, Zaninotto points out, and suggests that the Internet of Things is a possible way. The Internet of Things is a catch-all term for efforts to connect a wide variety of physical things to communication networks such as the Internet. It has tended to focus on infrastructure (buildings, roads, vehicles, factory equipment, *etc*.) and everyday devices: cars, door locks, contact lenses, clothes, toasters, refrigerators, industrial robots, fish tanks, light bulbs, toothbrushes, motorcycle helmets.

While the tech industry seems to have the goal of putting a computer inside everything, connecting everyone, another level of tools could be used to verify the contents of food delivered as part of a contract. Galvez, Mejuto & Simal-Gandara (2018) point out that the analytical techniques most commonly used to authenticate food (spectroscopies, separation techniques, mass spectrometries, stable isotope measurements, and DNA-PCR methods) could be used as tools in a blockchain-enabled food chain. The results of a text, once submitted to a blockchain, could trigger an action within a smart contract such as payment.

Blockchain in Wyoming

Many states don’t have a position on blockchain technology. Wyoming, however, was one of the first states to take an explicit stance. During its 2018 legislative session, the Wyoming Legislature passed – and the governor signed – five separate bills to smooth the way for blockchain technology to operate in the state. Advocates in the legislature hope that the efforts might help diversify the state’s economy (there is no notable tech industry

in the state – the largest industries are mineral extraction, tourism, and agriculture), but the state does have moderately priced electricity, which is an advantage to those in an energy-intensive industry such as computing.

The new laws do the following:

- **HB 19 "Wyoming Money Transmitter Act – virtual currency exemption":** called the "bitcoin bill," it provides an exemption from money transmitter licensing laws for virtual currency (*e.g.*, Bitcoin, Ethereum, etc.) used within Wyoming. It would allow operators of payment token exchanges to more easily operate in Wyoming.
- **HB 70 "Open Blockchain Tokens – exemptions":** called the "utility token bill," it provides that a person who develops, sells or facilitates the exchange of an open blockchain token (a "consumer" or "utility" token) is not subject to specified securities and money transmission laws. This means that issuers and dealers of so-called utility tokens can deal freely and not have to register as licensed broker-dealer firms.
- **SF 111 "Property Taxes – Digital Currencies":** defines tokens as property and exempts them from Wyoming property taxes.
- **HB 101 "Electronic Corporate Records":** provides for the maintenance of common corporate records, filings, and voting of Wyoming entities via blockchain so long as electronic keys, network signatures and digital receipts are used.
- **HB 126 "Limited Liability Companies – Series":** modifies Wyoming's corporate code to permit the formation of "Series LLCs." The intent is to promote Wyoming as a jurisdiction of choice for securities formation and to compete with Delaware and Nevada for corporate registration revenue.

Notable within the actions is that the state takes a position on a category of blockchain tokens that are called "utility tokens," which are tokens that are exchangeable for goods and services. Unlike "securities tokens," which meet the criteria of securities legislation to be called securities, utility tokens are specifically designated as exempt from securities and money transmitter laws, which had been perceived as a regulatory hurdle to trading cryptocurrencies.

Now that some time has passed since the laws came into effect, there have been numerous companies incorporated in the state. BeefChain, for instance, started in Wyoming in direct response to the deregulation. However, there is a sense that many who supported the bills did not have a full understanding of the implications of the regulatory efforts. While the attraction of new, high-tech companies to the state is a benefit, the potential risks, including the potential for fraud, hacks and illegal activity, may have been less well understood.

The state's blockchain task force – a group of 10 senators, representatives, and finance executives – have been working on the issue, and continue to develop their efforts with new legislation to support development of a sympathetic business environment.

Commodity Chains, BeefChain

BeefChain is a Wyoming company that started in early 2018 and has tagged roughly 1,500 cattle on five ranches throughout the state using radio frequency ID tags which are linked to a digital supply-chain ledger (McLannahan (2018) and del Castillo (2018)). The founders hope to take advantage of international trade opportunities from buyers interested in assurance on the (free range) living conditions of the livestock. Tagging the cattle was an initial step – the company must still select a blockchain platform and integrate it with the RFID chips.

Another example is the Northern Ireland brewery DownStream which describes itself as the "first to use blockchain technology, revealing everything you want to know about your beer, its ingredients and brewing methods." A scan of a QR code on a bottle with a mobile device reveals the information that the company has recorded and written to the blockchain, and uses this to provide transparency and prove authenticity.

Agricultural trade groups are curious about what use applications might develop using blockchain technology. Among them the US Soybean Export Council is interested since blockchain might help make the paperwork associated with trade lighter and go faster, notably for bills of lading and letters of credit. So, farm organizations may be looking for the opportunity to lower costs and increase efficiency, and perhaps provide information desired by consumers as a point of differentiation. However, at this point, the actual

applications have been very few. Once an industry standard has been developed, at some point in the future, all of the systems may be able to use a common platform. And at that point other issues will arise, such as, whose system is it? (A system owned by a for-profit company may be less preferred than one developed by a more benign entity).

Issues for Educators and Advisors

Advocates say that blockchain technology provides an efficient way of recording transactions, or any digital interaction, in a way that makes it secure, transparent, and auditable (since all previous transactions in the chain can be examined). And judged objectively, there is much that is worthy of examination from the perspective of a participant in a supply chain.

Yet blockchain's cryptocurrency products have been surrounded by misinformation and propaganda – the technology itself is sometimes described as "magic." Novice investors continue to be fooled into trusting con artists who are peddling products in the cryptosphere, and many seem interested in them, perhaps because of a fear of missing out. Further, cryptocurrencies seem to appeal to a sort of person inclined to seek out alternative explanations or motivated by fringe ideological motivations. For instance, recent articles on Infowars, a well-known conspiracy theory and fake news website, contains articles titled *Could Blockchain Change The World?: The global elite are afraid of financial power being controlled by a free market*. And *Central Banks Eye Blockchain Technology: Take heed to how monetary Tzars incorporate pro-liberty tech.* The nature of peer-to-peer transfer systems that cut out middlemen are born from libertarianism, and are almost anarchic in their nature.

Given the potential for weak thinking, the generous use of flimsy facts, and a culture of grievance, paranoia, and ideology, plus an undeveloped range of use applications and an unfamiliarity with the technology's risks, we, as advisors, would be well reminded that blockchain looks to be a remarkable technology, and there may be many ways in which our industry may embrace it. In the very early phases of this technology's development, it seems reasonable to say that blockchain is a way for vendors to sell new services, which so far are mostly of interest to large corporations. A recent paper by the US National Institute for Standards and Technology (Yaga, Mell, Roby & Scarfone, 2018) appeals to

the businessman side of those curious about blockchain: "Blockchain technology is still new and should be investigated with the mindset of 'how could blockchain technology potentially benefit us?' rather than 'how can we make our problem fit into the blockchain technology paradigm?'," noting that the temptation with a new technology is to apply it to every situation, even if it isn't appropriate. The authors list circumstances in which blockchain technology may be helpful:

- Many participants
- Distributed participants
- Want or need for lack of trusted third party
- Workflow is transactional in nature (*e.g.*, transfer of digital assets/information between parties)
- A need for a globally scarce digital identifier (*i.e.*, digital art, digital land, digital property)
- A need for a decentralized naming service or ordered registry
- A need for a cryptographically secure system of ownership
- A need to reduce or eliminate manual efforts of reconciliation and dispute resolutions
- A need to enable real time monitoring of activity between regulators and regulated entities
- A need for full provenance of digital assets and a full transactional history to be shared amongst participants

And we must be clear on the motivations for exploring blockchain and make sure that ample logical reasoning and sound explanations be applied to the information supplied by contacts on any business opportunities that develop. In short we should be careful not to be influenced by disinformation propaganda.

Conclusion

Blockchain technology is new and changing very fast; and wide adoption of it in the commercial market is still some time off. Tentative steps in various aspects of agriculture and in some regions of the country are exploring its potential. The initial use of blockchain created cryptocurrencies, and it can serve as an accounting tool and data ledger. Thus, it

could be used to account for arbitrary events such as changes in physical custody over materials and to create ledgers that are readable only to a small number of parties such as participants in a given supply chain.

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