Science Societies

Blockchain and production agriculture

How—and whether—it will be used still an open question

By Megan Sever

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Image courtesy of USFDA (https://bit.ly/2SUMDH6).

Consumers want to know more about where their food comes from, so fruit and vegetable growers and even some meat growers are implementing blockchains. But whether a blockchain system is necessary or even helpful for production agriculture is as yet undetermined.

One of the most famous skits from the sketch comedy *Portlandia* features a Portland couple at a restaurant, asking to know more about the chicken they are thinking of ordering for dinner. But rather than asking how the chicken is prepared, they start with: "Is that local?" Then, "Is that USDA organic or Oregon organic or Portland organic?" Eventually, after many more questions, the waitress brings out papers and pictures of their proposed dinner, named Colin, and they talk about how much room Colin had to roam and whether he was happy. The skit ends with the couple leaving the restaurant to drive 30 miles away to check out the farm where Colin was raised before deciding to eat him.

The skit is poking fun at hipsters. But the truth is, many consumers want to know more about where their food comes from. You may not have noticed, but strawberries come with a QR code now, which will indicate the farm the berries came from, when they were picked, and when they were packaged. Strawberries are one of many such items in the grocery store these days. All kinds of fruits and vegetables can be traced as can some meats. Restaurants are also getting into this game, tracing their cuts of beef

back to specific growers, for example, so patrons can be assured they're getting the authentic organic Wagyu beef from Wyoming they're paying a premium for and not a knockoff. Blockchain technology makes all of this possible.

Little did we know it, but pop culture has been introducing us to the idea of blockchain. Now the question is: Will it catch on in wider agricultural circles, and will we see it in production agriculture?

What Is Blockchain?

"Blockchain is a shared, distributed ledger that facilitates the process of recording transactions and tracking assets in a business network," says **Dennis Gerson**, an independent blockchain and agriculture expert based in the Dallas–Fort Worth area. The best way to think about it, Gerson says, is as a digital copy of "good old-fashioned double-entry bookkeeping." The assets tracked can be intangible, like a patent, or tangible, like a lot of grain or a head of livestock.



You may not have noticed, but strawberries come with a QR code now, which will indicate the farm the berries came from, when they were picked, and when they were packaged. Photo courtesy of Adobe Stock/Robert Kneschke.

Think of blockchain like a shared database similar to Google Docs, but rather than being able to change someone else's work, you can only see everyone else's work and add your own part to the database. And rather than Google owning the data and theoretically being able to change or cut you off from the data, the data are shared on a distributed group of computers in the cloud. Using blockchain creates a permanent, digitized, and decentralized record of all transactions in a sale. "The record is

immutable," Gerson says; it can't be changed.

In practice, every part of the supply chain becomes part of a blockchain. Not one link in the chain can opt out, or the whole system won't work. Someone in the chain chooses a platform and informs everyone else in the supply chain to start using the new system. In production agriculture, a blockchain might look like this: It starts with a seed supplier entering data into the blockchain on the seeds supplied to the farmer. The farmer enters data on everything about the crops: records on planting, fertilizing, irrigating, applying herbicides and harvesting, for example. These are primarily data farmers already record, Gerson says. They just would be recorded in the blockchain instead of personal ledgers. After harvest, the farmer hands off his crop to the grain elevator or the transport company, which tracks what they pick up and where, including data and pictures. The grain elevators, transporters, importers/exporters, customs, and retailers (as appropriate) then all record data at each handoff down the line with shipments fully tracked and each party paid at handoff, Gerson says.

"This enables people to get paid when the transaction occurs, when they hand the stuff over," Gerson says. This doesn't happen everywhere in the world, he notes.

If you search the internet for "blockchain," the first results relate to cryptocurrencies like bitcoin. The technology for blockchain started with cryptocurrencies, but blockchain has expanded and needs to be separated out from cryptocurrencies, Gerson says. Blockchain in agriculture does not need to use cryptocurrencies, he says, which come with a lot of unnecessary uncertainty.

Why Use Blockchain in Agriculture?

In agriculture, perhaps the best use of blockchain is for food safety and traceability, says **Will Secor**, an agricultural economist at the University of Georgia.

Remember the romaine lettuce recalls last year because of potential *E. coli* contamination? If the lettuce is part of a blockchain, it is traceable to a particular farm or a particular processor, and only lettuce from that farm or processor is thrown out.

Blockchain also enables consumers to get full information on their products, Gerson says. Take the *Portlandia* example. If that chicken were in a blockchain, the waitress could have pulled up a tablet and shown the consumers everything about that chicken. Data entry would start with the livestock supplier entering data on the egg and pullet quality, then the farmer fitting the chicken with an RFID chip, proving it's free range, and uploading data on feed, vet reports, sanitary conditions, and more. When the farmer sells the chicken for slaughter, the processor enters data on storage and slaughter conditions and food safety compliance while also giving the chicken products a QR code. The distributor uploads data on shipment, storage, transport, and delivery conditions. Then the retailer (store or restaurant) uploads data on delivery, storage, and sanitary conditions. Finally, the consumer scans the QR code and sees the entire cycle. Many consumers want this level of detail, Gerson says. They want to verify that their chicken is free range, their beef is grassfed, or their grains are organically grown without chemicals. Consumers are willing to pay a premium for premium products but only if they can be verified. With blockchain, assuming every link in the supply chain is visible and every participant has uploaded their data, growers can differentiate their premium products and thus charge more money.

Blockchain is also touted as increasing efficiencies and lowering costs throughout the supply chain. Blockchain optimizes logistics and data management, requiring, for example, one copy of a bill of sale rather than everything in triplicate, Secor says. Using the blockchain technology allows everyone a better way to maintain records, he says. Blockchain can also remove middlemen, which could be especially helpful in developing countries, where the middleman stage is often fraught with fraud.



Remember the romaine lettuce recalls last year because of potential E. coli contamination? If the lettuce is part of a blockchain, it is traceable to a particular farm or a particular processor, and only lettuce from that farm or processor is thrown out. Photo by Stephen Ausmus, USDA-ARS.

Blockchain not only makes recordkeeping easier, but it also increases transparency, thus reducing the likelihood of fraud at all levels. If a purchaser in Korea buys crops from the U.S., blockchain enables the purchaser to see that the grower is actually growing what the purchaser is paying for, Gerson says. It also reduces the ability to sell one crop to two different buyers, kite a check, or sell a stolen herd, he says. “Blockchain stops the ability to sell an asset twice because everyone in blockchain has a copy of the ledger,” he says. This scenario in agriculture is rare, he adds, because people are mostly honest. But it’s still good that “you can’t hide anything.”

Blockchain transparency also gives small farmers a bit more power. Say a buyer receives the goods and decides they're not going to pay the farmer the contracted price, maybe because market prices changed or maybe they're being dishonest and saying the product doesn't look right. Usually, in cases like this, small farmers have no recourse. Using blockchain, farmers would have digital proof of the goods' quality when they left the farm and a smart contract that activates immediately.

Blockchain doesn't completely eliminate the possibility of fraud, Gerson says, but it vastly improves the transparency in all transactions.

Blockchain in Practice

Currently, Gerson says, there are four primary uses of blockchain in agriculture: (1) tracking breeding stock in livestock (especially helpful for high-value breeding stock and preventing modern cattle rustling in emerging markets); (2) tracking high-value agricultural assets from farm to shelf (like Wagyu beef or fair-trade coffee); (3) tracking commodity products from farm to shelf (mostly done with fruits and vegetables, and some meats/dairy); and (4) tracking and optimizing commodity contracts. Some commodity growers of row crops and grain are already using blockchain in Asia and Europe, Gerson says, especially for wheat, soybean, corn, and rice. But in general, it's still a "nascent, emerging technology."



Blockchain enables consumers to get full information on their products. Livestock could be fitted with an RFID chip, and data would be uploaded on feed, vet reports, sanitary conditions, and more. Photo courtesy of Adobe Stock/lukesw.

The most promise so far for blockchain in production agriculture is in international trade, Gerson says. In this case, you still have futures contracts that move along the grain from farm to silo to barge to export/import to processor, but the difference is that the futures company acts like an import/export bank and pays everyone along the way, he says. Outside the U.S., major agricultural trading companies like Louis Dreyfus are using blockchain to track the assets, "so they can provide bridge loans for all the various people involved to pay their bills along the way."

A number of large companies have been implementing blockchain. Walmart was one of the first, partnering with JD.com and Tsinghua University in China and IBM to launch the Blockchain Food Alliance in 2017. In 2018, IBM spun off that successful venture to create the Food Trust blockchain technology, again partnering with Walmart, to track food items from a store to a source in seconds (rather than days).

In 2018, AgroCorp started a blockchain connecting 4,500 farmers in Australia with stores and restaurants—end consumers for their products. Since then, AgroCorp has expanded its blockchain to include more countries and more commodities. Last April, U.S.-based Cargill paired with AgroCorp on a trade that sent $12 million of wheat from North America to Indonesia using a blockchain platform called Hyperledger Fabric (DLT ledgers).



A worker processes food shipments in a warehouse. Photo courtesy of IBM.

"Usually, trading a large amount of grain from one country to another is a complex, time-consuming process," wrote author Jack Ellis in a **story about the Cargill–AgroCorp trade on AgFunder News April 16, 2020**. Even when two parties have agreed to a deal, he wrote, the steps to sale are numerous, from quality control to shipping to customs clearance. Plus, the transaction must be financed by banks. "That means that any one trade [involves] a lot of players and a lot of moving parts," Ellis wrote. Blockchain can streamline the process, he noted, especially by "increasing trust and traceability … from trade documentation such as letters of credit, waybills, bills of lading, and other contracts." Using blockchain for this transaction cut transaction time for the trade from about a month to **five days**.

GrainChain is another big player in this field, or at least is aiming to be, trading 24 different grain varieties with thousands of members in the U.S., Mexico, and Honduras. GrainChain is a Texas-based start-up, begun by the founders of SiloSys, a blockchain-enabled inventory management system that's been processing commodities since 2013.

GrainChain relies on smart contracts that self-execute when agreed-upon terms are met, plus SiloSys for inventory management, HarvX for logistics, and Trumodity as the trading platform. The GrainChain approach, the company notes on its website, solves "industry-wide problems, including inefficient processes based on manual data entry and paper records, limited traceability, fraud at all stages of the supply chain, large- and small-scale corruption, payment delays, access to the commodity futures market,

and a cycle of debt that is difficult to escape."



For blockchain to work, everyone in the supply chain needs to see benefits. Illustration courtesy of Adobe Stock/Feodora.

Challenges to Widespread Adoption

Cutting transaction time, especially where grains are held in ports waiting for paperwork to be verified, is a big selling point for production agriculture growers to buy into blockchain. But in 2018, when the U.S. National Grain and Feed Association (NGFA)—an organization whose members handle more than two-thirds of all grains and oilseeds in domestic and export markets—was choosing to offer a digitized barge paperwork option to the industry, the organization elected not to go with a blockchain. Instead, NGFA decided to develop its own system for barge certificates and paperwork in collaboration with essDOCS. Called the **National Grain and Feed Digital Solutions Barge Digital Transformation System**, the database "is designed to address barge bills of lading on southbound traffic for corn, wheat, soybeans, [dried grains with solubles] and soybean meal on the Mississippi River System," the organization describes on its website. But, the NGFA states that the database system also "has the potential to be expanded in the future, including to other regions, such as the Columbia and Snake River System in the Pacific Northwest."

Barge-shipping paperwork trails are immense and messy, Secor says. Members of NGFA handle some 70,000 to 100,000 barge bills of lading each year, so blockchain was discussed to reduce the paperwork. But NGFA went with a nonblockchain solution that is likely less expensive, he says. This was possible, at least in part, because there's a strong institutional governance structure within agriculture, he says, and strong trust among different companies.

Where trust is not as strong or where governance is not ideal, blockchain can help create trust and a system that is open and transparent for all. But some significant barriers stand in the way of widespread adoption.

One such barrier is government regulation and involvement (or lack thereof), wrote Jonathan Johnson, CEO of Overstock.com and president of Medici Ventures (a major investor in GrainChain), in a commentary in *Fortune* July 7, 2020. Johnson likens the current environment—recovering from a global pandemic and global recession—to the period of telecommunications regulation overhaul in the early 1990s that led to the internet boom. Like the internet, he wrote, blockchain can be a "vital driver of the new normal as industries and economies recover from the pandemic," but "collaboration between all stakeholders—including government agencies—is essential to the future adoption of blockchain technology."

"Companies need the freedom to develop blockchain technology without onerous oversight," but it's also crucial that the U.S. government moves quickly, Johnson wrote. China is already urging its financial institutions to support blockchain, he noted, "which could prove very problematic" if the U.S. does not follow suit.

Another concern is privacy. Although blockchain systems are designed to promote transparency, Gerson says, the systems allow for protection of patents, field locations,

proprietary information, and other trade secrets.

Technology may present challenges too, Secor notes. The blockchain needs enough computing power (easily solvable on the cloud-based platforms). Farmers and businesses at every step along the supply chain need the technology and training/know-how to upload important information, he says. But the technological knowledge shouldn't be much more than signing into an online bank account or entering data in an Excel spreadsheet, he says. Still, the idea of a new technology could be a barrier to entry.

In fact, probably the two biggest barriers to entry in agriculture both have to do with people rather than technological systems: getting people to try something new and unknown, Secor says, and getting all the players at the table to be "brutally honest" with each other, Gerson says.



Illustration courtesy of Adobe Stock/LuckyStep.

Finally, Secor notes, for growers to buy into this system, they need to be incentivized; they either need to save money or make more money. That's true of everyone in the supply chain: Everyone needs to see benefits. In the case of specialty products like organic produce, everyone in the supply chain benefits by cooperating and sharing their data because they can collectively charge more by proving provenance. In the case of row crops and grains, the benefits aren't as obvious, Secor says. Farmers may get their products exposed to greater markets and the paperwork trail may be easier for everyone, plus it's probably worth something to farmers to be able to trace their own goods through the whole system. But until the benefits become clear for the production agriculture industry, it will be hard to get blockchain to take off, Secor says.

CoBank notes that corn would be the easiest crop to move into blockchain because it has the simplest trade specifications under the Federal Grain Inspection Service. Soybeans and wheat would be next.

What Do You Need to Know?

Although enterprising growers can request their co-ops find a blockchain to join, growers and CCAs are not responsible for setting up a blockchain; that dictum will come from someone higher up the supply chain, Gerson says—probably the broker or the end consumer (like an animal feed processor). Individual growers—or more likely co-ops—will be asked to join a blockchain network that the broker or consumer company sets up. If they choose to join, they will then be required to upload the requested information to a shared network. Most of the information required is already keep by growers, so it shouldn't be that different, Gerson says.

Growers don't have to participate. But if they choose not to participate and everyone else in their supply chain does, the nonparticipants will be shut out of any contracts within that supply chain.

The risks to becoming an early adopter of a legitimate blockchain-based market/technology are few, Secor notes—basically just the cost of time learning the new program. So even if that blockchain fizzles out, as several have done in the last few years, growers won't be out much. The risks of not being an early adopter or at least a "fast follower," he says, are greater: If the writing on the wall says everyone's starting to get into blockchains, then you better do it too, or risk being left behind and seeing your products have a reduced market.

Secor says CCAs and growers need to be familiar with the concept of blockchain but not be concerned about adopting it yet.

Ultimately, Secor says, blockchain is a tool, and until the benefits in production agriculture become obvious, the technology is probably not going to be adopted widely. Technologies are adopted in response to an unmet need, he says. In specialty meats or fruits and vegetables, for example, the need was tracking and verifying the product's provenance. Within row crops that aren't traded internationally, it's hard to see the value-add of blockchain, he notes. So for now, he says, you can probably just consider blockchain as "one more tool that's out there"—and keep an eye on it.

More crop management

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