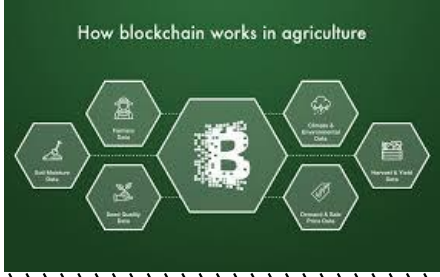

BLOCKCHAIN FOR AGRICULTURE:

PROMISE, POTENTIAL & REALITY

NATHAN DELAY
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DEPARTMENT OF AGRICULTURAL ECONOMICS

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WHAT BLOCKCHAIN IS

A BLOCKCHAIN IS SIMPLY A DATABASE SHARED ACROSS MEMBERS OF A NETWORK

- **Distributed**: The database (or ledger) is shared across a network—everyone has a complete and up-to-date copy, no more siloed information.
- **Decentralized**: No central authority is solely responsible for what is entered in the ledger—exchanges can be made peer-to-peer without a third party.
- **Consensus driven**: Updates can only be made to the blockchain if validated by all members of the network according to the specific criteria of the blockchain.
- **Immutable**: Data can only be added. Once written to the blockchain, information cannot be altered—no manipulation.

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WHAT BLOCKCHAIN IS NOT

BLOCKCHAIN IS NOT BITCOIN ≠

- Bitcoin (and most other cryptocurrencies) is built on blockchain technology but blockchain has many applications beyond cryptocurrencies.

BLOCKCHAINS NOT BLOCKCHAIN

- Blockchain is not singular—there are many blockchain platforms (e.g. Ethereum and Hyperledger).

BLOCKCHAIN IS NOT A PANACEA

- Blockchain is still in its infancy and far from a mature technology.

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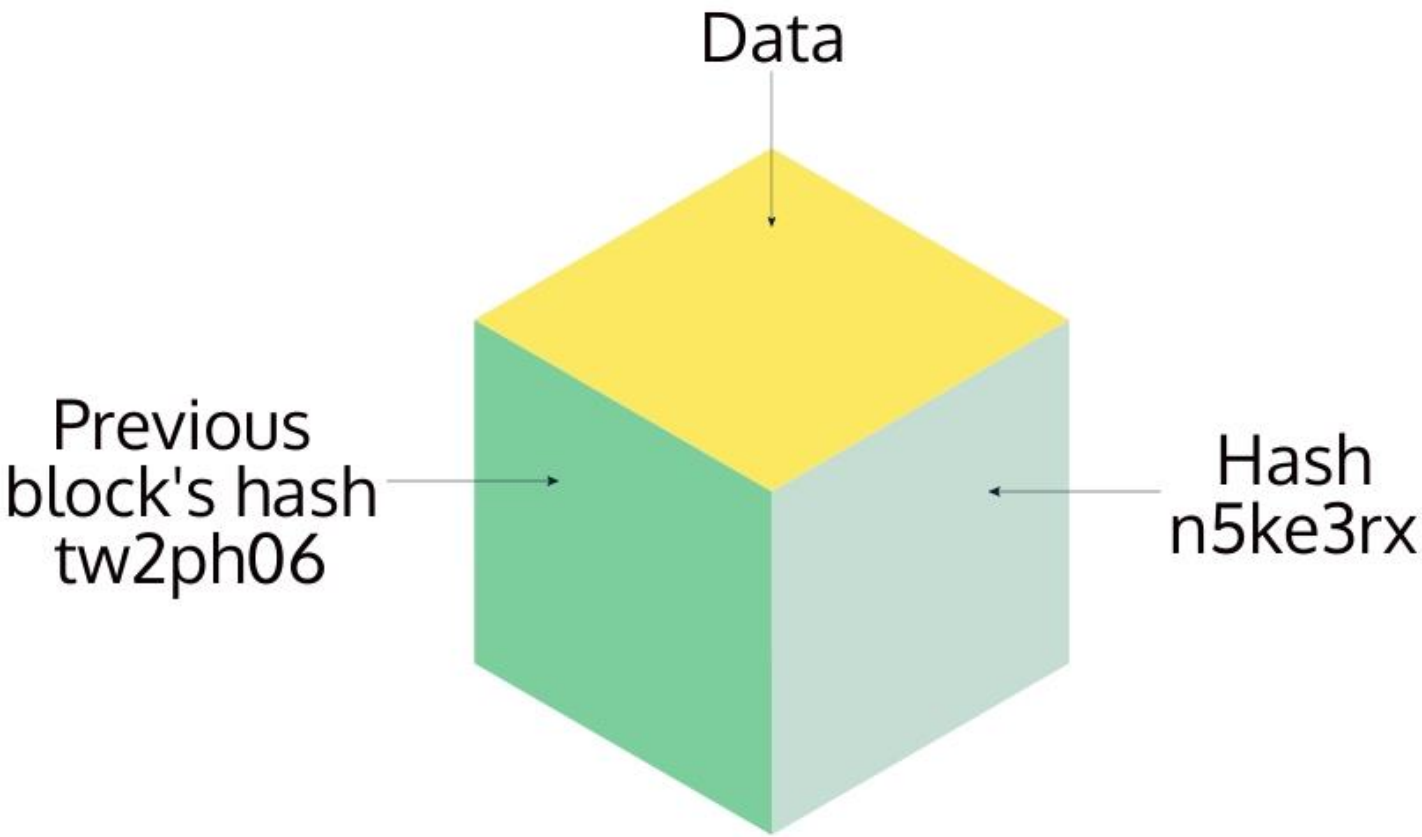
HOW DOES BLOCKCHAIN WORK

EACH BLOCKCHAIN BLOCK CONTAIN 3 ELEMENTS:

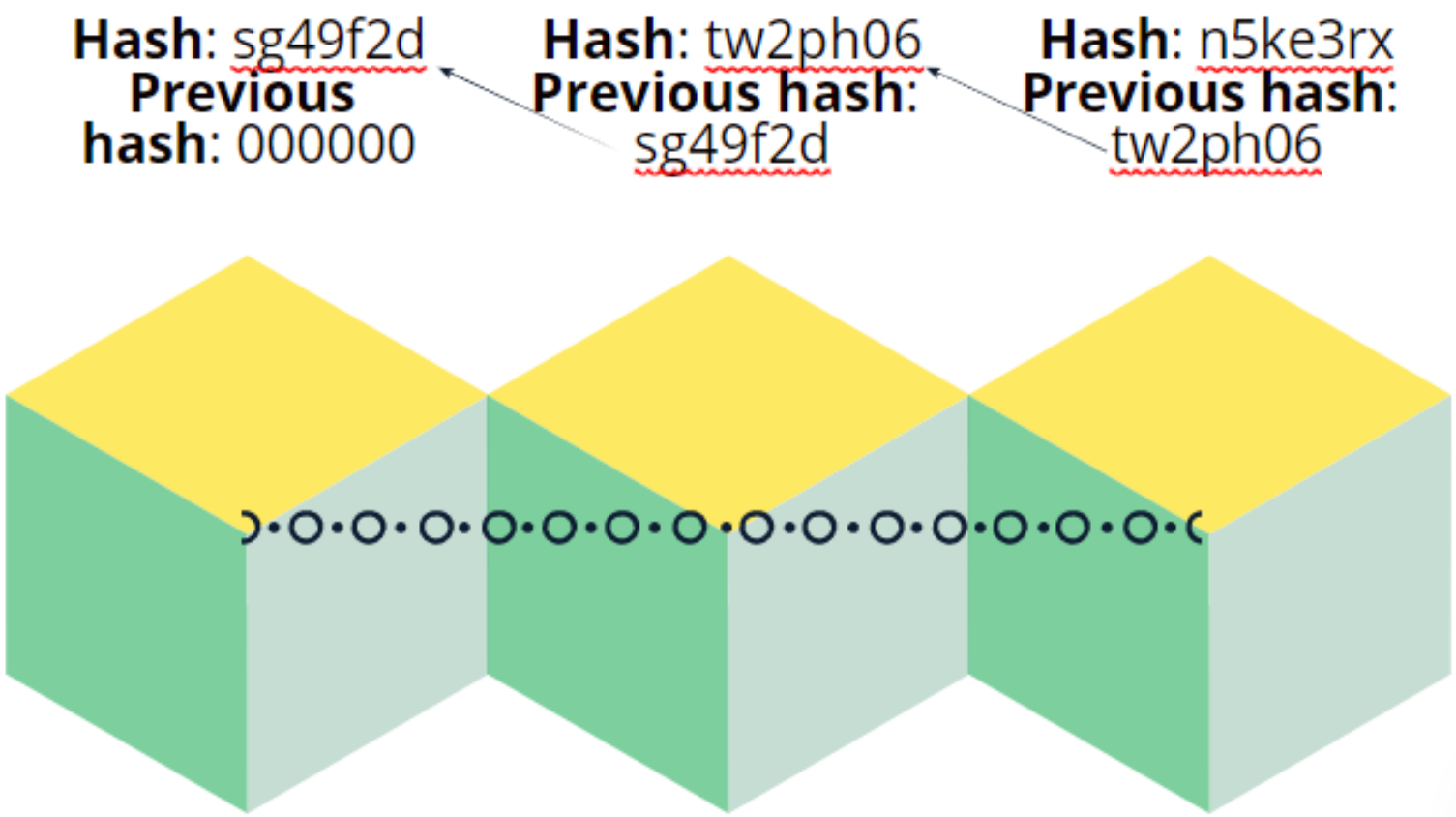
1. Data – New information being added to the blockchain
2. Hash – Unique code identifying the data
3. Hash of the previous block



HOW DOES BLOCKCHAIN WORK

BLOCKS ARE LINKED TOGETHER WITH HASHES

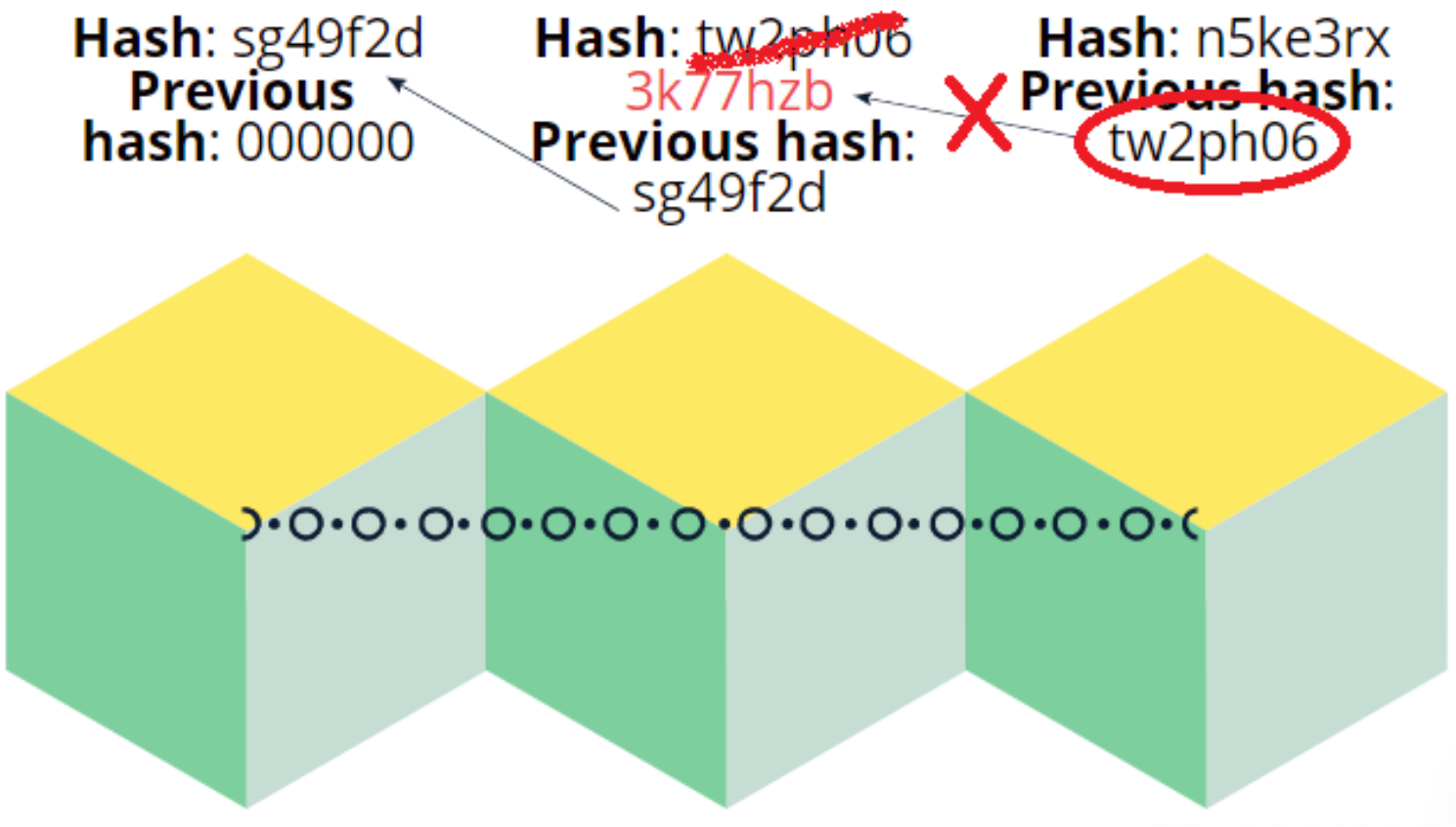
Hashes act like digital fingerprints, unique to each piece of data. Each block includes its own hash and the hash of the previous block.



HOW DOES BLOCKCHAIN WORK

BLOCKS CANNOT BE ALTERED WITHOUT ALTERING ALL FOLLOWING BLOCKS

If the underlying data changes at all, its entire hash changes and the link between it and the following block becomes invalid.



HOW DOES BLOCKCHAIN WORK

AUTHENTICATION OF NEW BLOCKS

- Authentication is built upon “consensus protocols”—pre-agreed upon standards for validating entries into the blockchain.
- A majority of “nodes” (network participants) must agree to approve new blocks.
- Decentralization means there is no central authority solely responsible for authenticating new blocks.

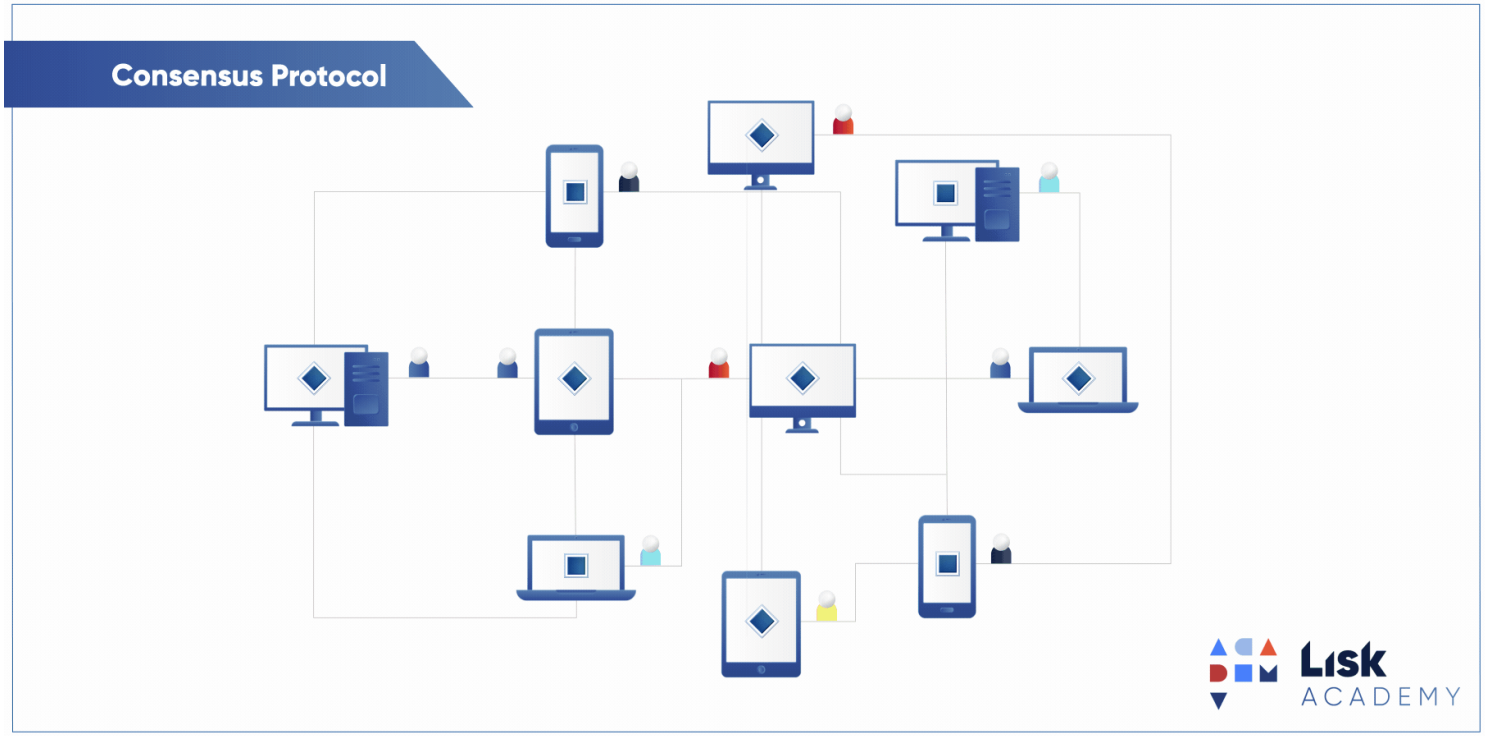


Image source: LisK Academy

BLOCKCHAIN USE CASES FOR AGRICULTURE

BLOCKCHAIN CAN ADDRESS CHALLENGES IN THE FOOD SYSTEM FOR BOTH CONSUMERS AND PRODUCERS

- **Demand side**:
  - Food safety/traceability
- **Supply side**:
  - Agricultural trade

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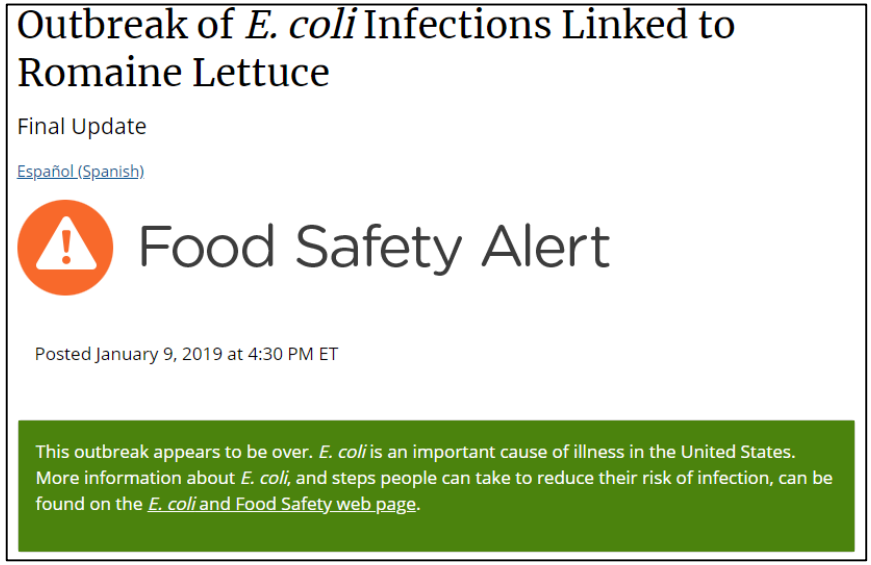
BLOCKCHAIN USE CASES FOR AGRICULTURE

FOOD SAFETY & TRACEABILITY

- Foodborne illness costs the U.S. more than $15.6 billion annually (USDA, 2014).
- It can take weeks to identify the source of an outbreak.
- Blockchain creates a transparent record from farm to shelf, dramatically reducing time and cost in the event of an outbreak.
- RFID codes can record temperatures, holding times, etc. throughout the supply chain—allowing problems to be intercepted before reaching retailers.



Outbreak of *E. coli* Infections Linked to Romaine Lettuce

Final Update

Español (Spanish)

Food Safety Alert

Posted January 9, 2019 at 4:30 PM ET

This outbreak appears to be over. *E. coli* is an important cause of illness in the United States. More information about *E. coli*, and steps people can take to reduce their risk of infection, can be found on the *E. coli* and Food Safety web page.

Source: CDC

Outbreak Investigation of E. coli O157:H7 Linked to Romaine Lettuce Grown in CA

FDA publishes summary of factors potentially contributing to the Fall 2018 outbreak.

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February 13, 2019

The FDA has completed its investigation of the multistate outbreak of *E. coli* O157:H7 illnesses linked to romaine lettuce grown in California in Fall 2018. On February 13, 2019, FDA released an overview of the investigation approach and factors that potentially contributed to the contamination of romaine lettuce with *E. coli* O157:H7 in this outbreak: **Investigation Summary: Factors Potentially Contributing to the Contamination of Romaine Lettuce Implicated in the Fall 2018 Multi-State Outbreak of *E. coli* O157:H7**. This document also provides recommendations to industry for prevention of pathogenic *E. coli* O157:H7 contamination that is based on the findings outlined in the document.

Additionally, FDA offers the following recommendations to industry to develop and enhance commodity-specific procedures, policies and best practices to enhance the safety of leafy greens:

Source: FDA

BLOCKCHAIN USE CASES FOR AGRICULTURE

FOOD SAFETY

- Walmart and IBM are working to ensure food safety with blockchain.
  - Time needed to identify the origin of sliced mangoes went from 7 days to 2.2 seconds with blockchain.
  - For pork in China, a blockchain system allowed for the uploading of certificates of authenticity—bringing trust to the system.
  - Requiring all suppliers of leafy greens to trace their products back to the farm using blockchain.

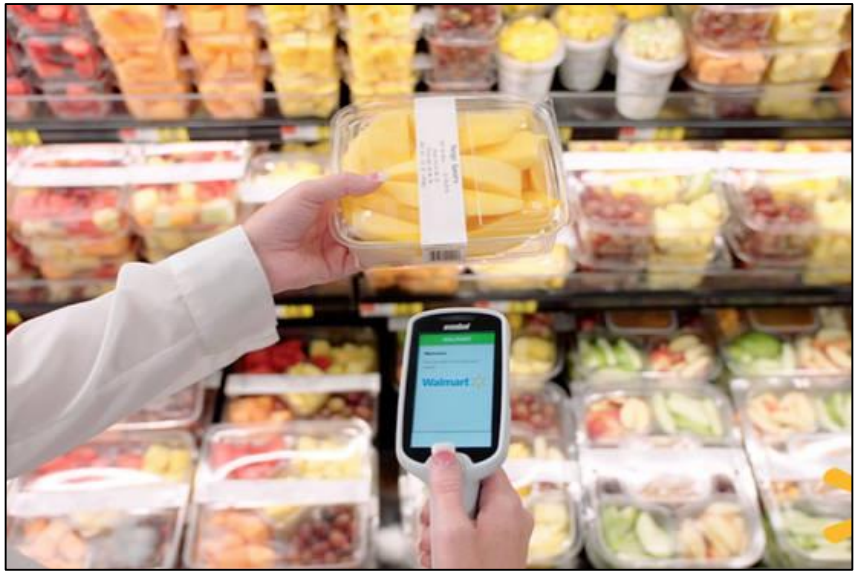

Image source: The Wall Street Journal

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BLOCKCHAIN USE CASES FOR AGRICULTURE

SUSTAINABILITY

- Blockchain can help meet consumer demand for “clean” food.
- Existing certification/labeling systems are insufficient and complicated.
- Consumers may pay a premium if sustainability claims are trustworthy.
- **Crop production**
  - Production practices recorded and certified by third-parties, authenticating claims about non-GMO seeds or pesticide use.
  - Automatically upload equipment data on chemical application, fuel use, and carbon emissions.
- **Animal agriculture**
  - Ethical raising of animal products can be demonstrated to validate claims about sustainable harvesting or animal welfare.

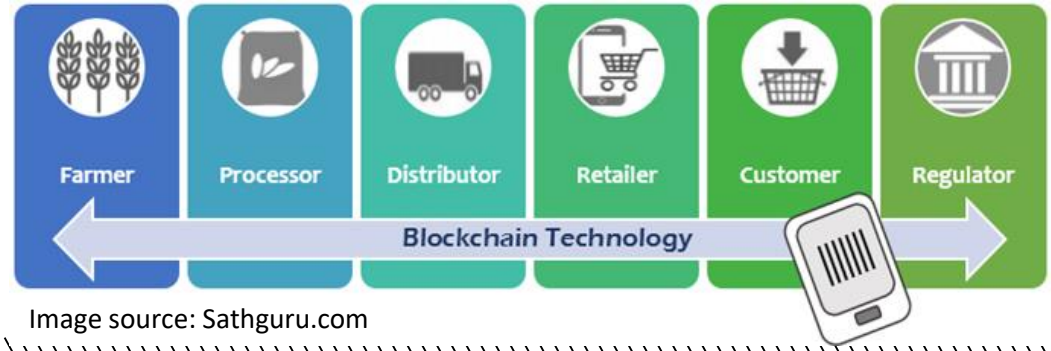

Image source: Sathguru.com

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BLOCKCHAIN USE CASES FOR AGRICULTURE

SUSTAINABILITY

- The World Wildlife Fund piloted OpenSC—a blockchain platform that tracks the harvest and shipment of wild fish.
  - GPS location is recorded to ensure fish were caught in legal fishing waters.
  - Fish are tracked using RFID codes from source to the processor.
  - QR codes are placed on each fillet, giving consumers information on its source and harvest practice.

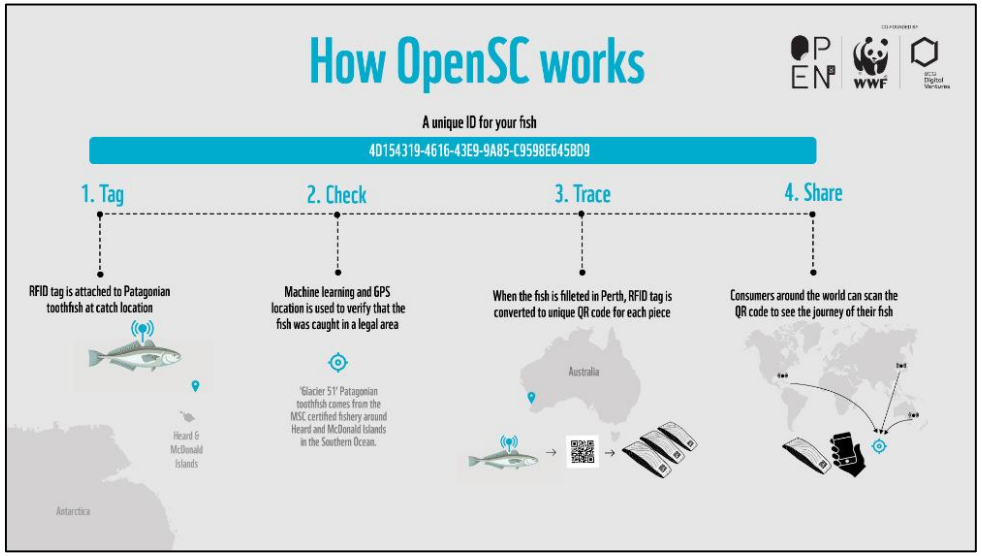

Image source: World Wildlife Fund-Australia

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BLOCKCHAIN USE CASES FOR AGRICULTURE

AGRICULTURAL TRADE

- Cross-border shipments of agricultural products involve large amounts of paperwork—invoices, letters of credit, customs forms—among multiple parties—shippers, buyers, banks, port authorities, customs officials.
- Manual document processing is costly and inefficient—often documents must be physically sent back and forth between parties multiple times.
- Blockchain can digitize the process, sharing all documentation simultaneously across parties.

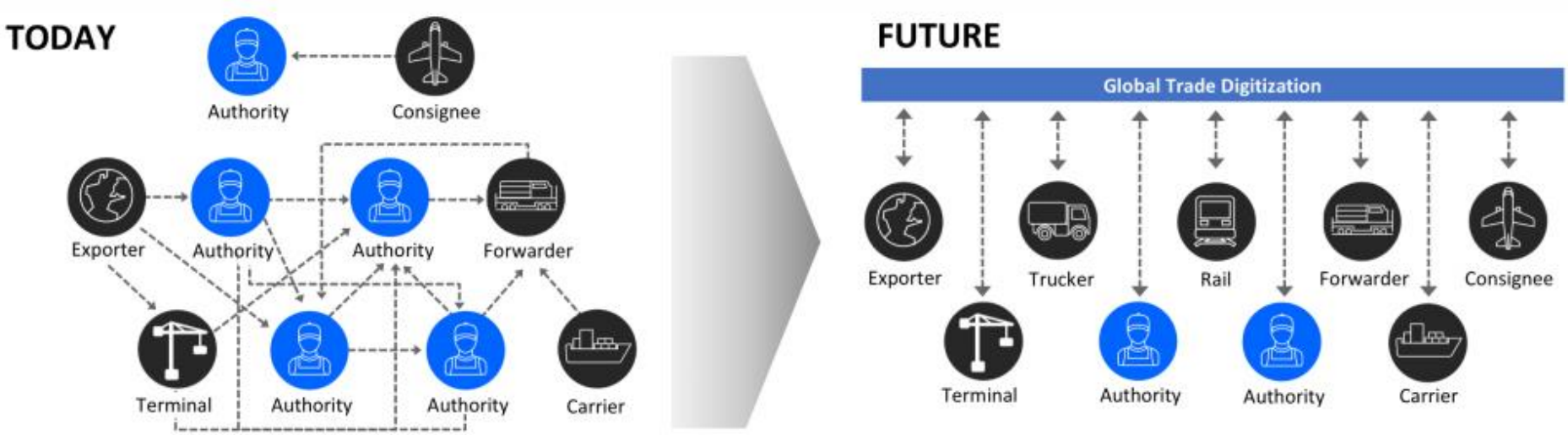

Image source: IBM

BLOCKCHAIN USE CASES FOR AGRICULTURE

AGRICULTURAL TRADE

- Dec 2017: Louis Dreyfus Company (LDC) and partners complete the first ever blockchain-based agricultural commodity trade—document processing time was cut five-fold.
- Oct 2018: ADM, Bunge, Cargill, and LDC announce they are investing in blockchain and AI systems for the benefit of the industry.
- Global sugar traders are exploring blockchain solutions for the sugar industry.

Commodities trader Louis Dreyfus turns to blockchain

Company completes first agricultural deal using the digital technology

News · Supply chain

Agribusiness companies form blockchain consortium

10 months ago · by Ledger Insights

Sugar Traders Follow Agri Giants in Seeking Blockchain Fix

By Isis Almeida

February 13, 2019, 11:49 AM EST *Updated on February 13, 2019, 10:00 PM EST*

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BLOCKCHAIN USE CASES FOR AGRICULTURE

GRAIN MARKETING

- Farmers can wait several weeks for payment for grain sold to elevators.
- Grain sales involve manually entering weight, quality, and moisture—subject to human error or fraud.
- Blockchain can facilitate instant ownership transfer and payment on delivery for grain—reducing transactions costs.

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BLOCKCHAIN USE CASES FOR AGRICULTURE

GRAIN MARKETING

- GrainChain
  - Blockchain-based grain merchandising platform connecting farmers and buyers.
  - IoT technology, sensors, and software record inventory and certify quality of sold grain.
  - Once shipment is verified, invoice settlement, ownership transfer, and payment take place immediately.

Image source: GrainChain website

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BLOCKCHAIN USE CASES FOR AGRICULTURE

SMART CONTRACTS

- Much of the efficiency gains of blockchain for supply chains come from the use of “smart contracts.”

- Smart contracts set pre-defined conditions in a blockchain.
  - International trading context – all requirements of the sales contract.
  - Grain marketing context – quantity of grain, moisture content, time of delivery, GMO vs. non-GMO.

- Once the conditions are met, the blockchain automatically initiates a pre-defined action.
  - Blockchain consensus protocols verify when the requirements are satisfied.
  - Transfer of ownership
  - Release of payment to seller

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Upshot

Will Blockchain Become More Prominent?

Highly Likely

- Drivers For:
  - Transparency
  - Trust
  - Efficiency
  - Error reduction
- Drivers Against:
  - Reputation
  - Fear
  - Over promise

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