UNIVERSITY of GUELPH
ONTARIO AGRICULTURAL COLLEGE
DEPARTMENT OF FOOD, AGRICULTURAL AND RESOURCE ECONOMICS

# Trade, Competitiveness and Blockchain: Productivity, Innovation, and Product Differentiation

**Project #:** UofG2017-2972

Project Lead: Getu Hailu

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# The Applications of Blockchain Technology in Agri-Food sector

**Presented By:** Jamieson Westover, M.Sc. Candidate,
Department of Food, Agriculture and Resource Economics,
University of Guelph

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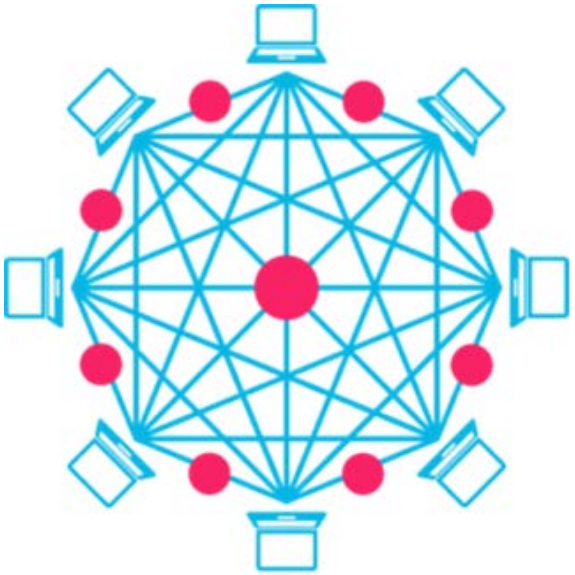

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# Blockchain Technology Overview:

What is Blockchain Technology?

- Blockchain Technology refers to a digital, distributed ledger that facilitates the process of executing and recording transactions between two parties.*

- Uses cryptography to operate a decentralized network of parties that can engage in transactions with one another in the absence of a third-party.

- Provides users with a new way of storing data and facilitating transactions.

*****Blockchain gained its notoriety through the introduction of the cryptocurrency Bitcoin in 2009. Bitcoin was introduced to provide individuals with an alternative to fiat currency in which owners of the digital assets ("Bitcoin") could buy, sell and trade digital currencies without intervention from governments or financial institutions.

# Blockchain Technology Overview:

What is Blockchain Technology?

- The primary benefits of Blockchain Technology stem from decentralization.*
- Decentralization eliminates the requirement of trusted-third parties for the purposes of verifying, executing and recording transactions between parties.
- This results in transactions that are **secure**, **fast** and **cheap.**

*****Existing systems that enable transactions between parties typically relied on centralized systems in which one party or organization “owned” the ledger (or log of transactions)

# Blockchain Technology Overview:

What is Blockchain Technology?

- **Blockchain Network:** A peer-to-peer network of participants (computers) using blockchain technology to jointly manage a database of transactions.
- **Permissioned (Private) Network:** A Blockchain Network that requires granted access by the owner/operators of that network.
- **Permission-less (Public) Network:** A Blockchain Network that any individual can participate in. (e.g., Bitcoin)

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# Blockchain Technology Overview:

What is Blockchain Technology?

## Four Characteristics of a Blockchain Network:

1. **Consensus:** Validation of a transaction depends on general agreement amongst participants in a Blockchain Network*

2. **Provenance:** Users are able to observe an assets' origin and movement

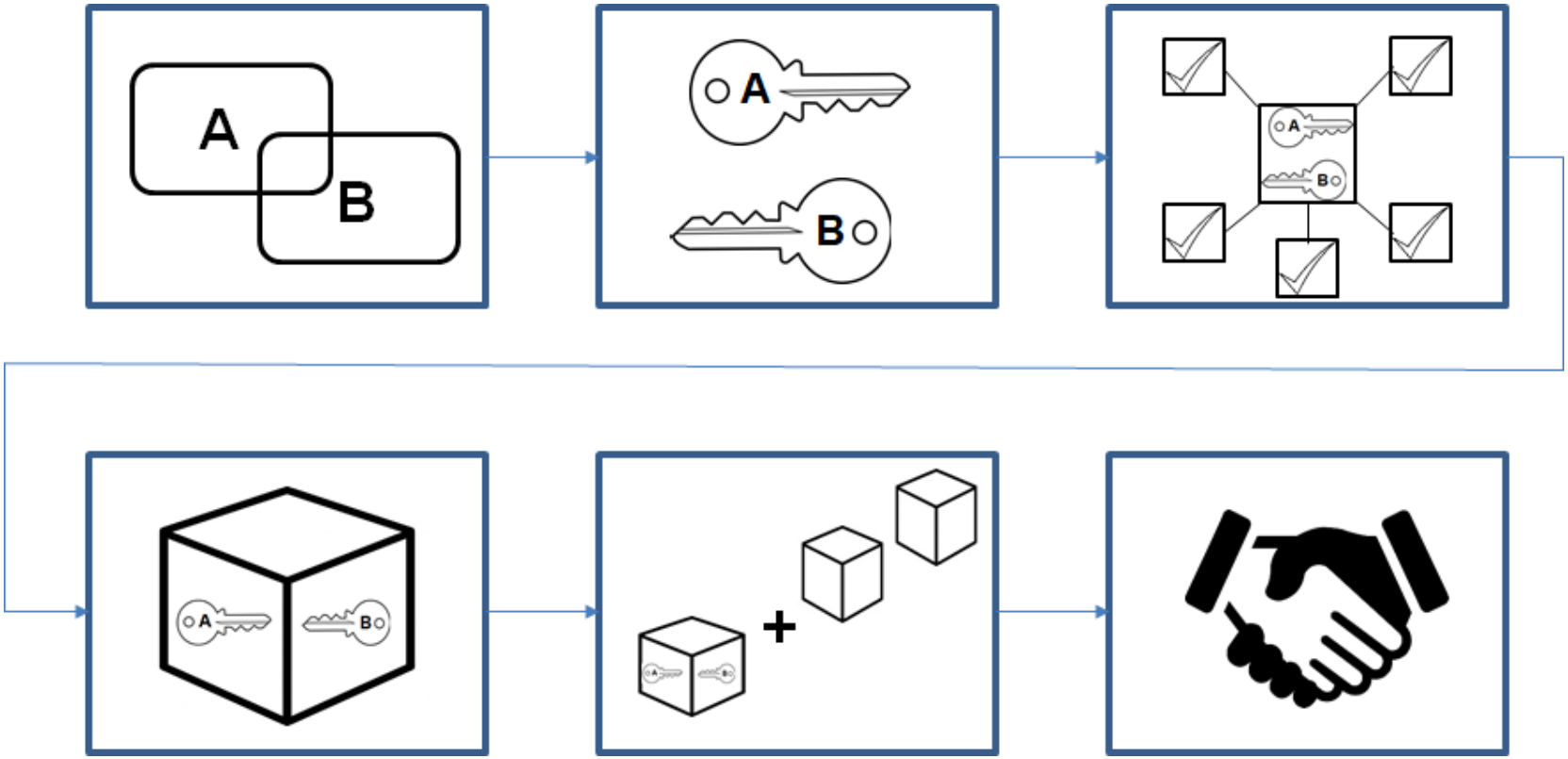
3. **Immutability:** Blockchain networks are highly tamper-proof as no transaction can be reversed and/or edited

4. **Finality:** A single, distributed (decentralized) ledger is available to all parties and maintained by all participants and not a single owner

*****There are many methods of cryptography-enabled consensus available such as "proof of work" and "proof of stake."

# Blockchain Technology Overview:

What is Blockchain Technology?



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# Blockchain Technology Overview:

Potential Benefits and Barriers

## Benefits of Blockchain Technology Use

- Security and Immutability
- Time and Cost Savings
- Reduction of Information Friction (Transparency)
- Enables “trust-less” Interaction
- Flexible
- Smart Contracts

## Barriers to Blockchain Technology Use

- Latency
- Energy-Intensive*
- Compatibility with Legacy Systems
- Regulatory Uncertainty
- Economies of Scale Issue (Scalability)

*****The energy and associated financial costs of completing a transaction on a Blockchain network depend on the cryptographic methods used and orientation of the network

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# Blockchain vs. Existing Technology:

Differences and Advantages of Using Blockchain Technology

**Existing Technology**

- RFID
- Barcodes
- Paper-Based Record Management
- Financial Institutions/Clearing Houses
- Enterprise Resource Planning Software


| Existing Technology | Potential Benefits of Blockchain |
|---|---|
| • Centralized<br>• Susceptible to Human Error, Fraud<br>• Disjointed<br>• Inefficient (slow, high transaction cost) | • Decentralized<br>• Increased Security<br>• Collaborative<br>• Transparency<br>• Lower Transaction Costs |

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# Blockchain Technology Overview:

What Problems can Blockchain Solve?

- **Reduce Information Asymmetry**
  - Increased visibility of information flow
  - Increased transparency of asset movements

- **Reduce Transaction Inefficiencies**
  - High transaction costs
  - Lengthy settlement times
  - Contractual disputes
  - Inventory Mismanagement

- **Reduce Fraud/Human Error in Record Keeping**
  - Smart contracts
  - Decentralized Autonomous Organizations (DAO's)
  - Increased security of information and data

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# Blockchain Technology Overview:

What Problems can Blockchain Solve?

Advocates of Blockchain claim the technology can solve problems related to:

- **Complex supply chains**
  - Legal requirements for traceability of products
  - Costly/inefficient record keeping practices
  - Large number of supply chain stakeholders
  - Vulnerability to cyber-attacks

- **Transaction Frictions**
  - High transaction volumes and/or costs
  - Slow transaction speeds
  - Information asymmetry
  - Market power occupied by Trusted Third Party's

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# Current Research on Blockchain Technology:

Where can Research on Blockchain Technology be Found?

1. White Papers
2. Government Publications
3. Consulting Reports
4. News Articles
5. Case Studies (Pilot Programs)
6. Academic Publications*

*The majority of academic research examining Blockchain Technology is found is computer science, engineering, information sciences and business management publications

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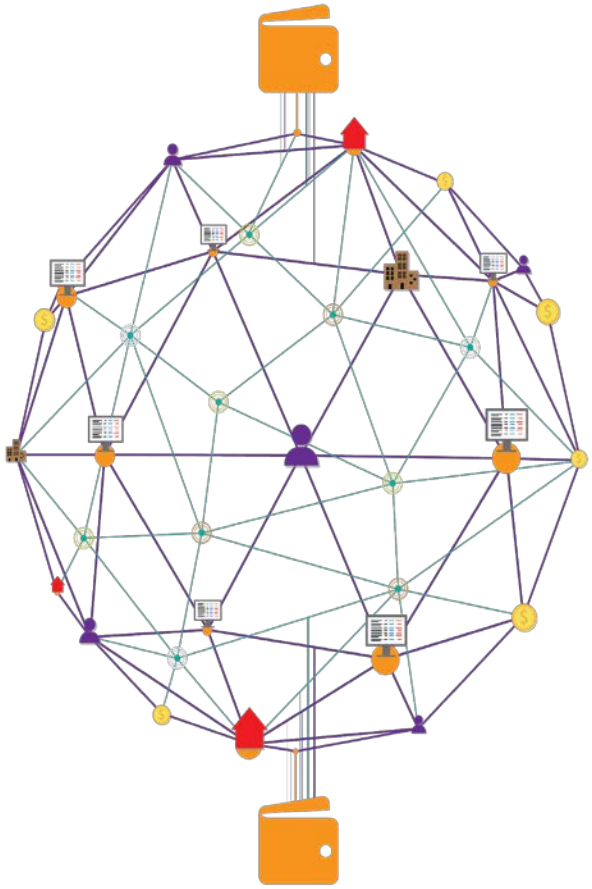
# Current Research on Blockchain Technology:

Research Focus (4)

- **Payment Processing and Financial Transactions**
  - Reduction in transaction costs and frictions
  - Instantaneous payment and contract settlement
  - Immutable history of financial transactions
- **Driving Efficiency of Supply Chains**
  - Automation of transactions
  - Reduction in human error
  - Improving inventory turnover
  - Minimizing bullwhip effects (cost minimization)
- **Increasing the Transparency of Supply Chains**
  - Food and product safety
  - Quality assurance
  - Supply chain coordination
- **Minimizing Fraud, Contractual Disputes and Human Error**

# Non-AgFood Industry Applications of Blockchain

1. Financial Services
2. Retail Sector
3. Logistics/Supply Chain Mgmt.
4. Insurance Industry




# Industry Applications of Blockchain:

Financial Services

**Organization: Ripple**
**Application:** Allows for on-demand, instantaneous settlement of payments between parties

**Organization: Aeternity**
**Application:** Provides companies with a platform to manage high volumes of financial trades and micro-payments

**Organization: Securency**
**Application:** Allows for individuals and companies to trade digital assets with assets of any kind (incl. non-digital assets)

# Industry Applications of Blockchain:

Retail Sector

**Organization: Waranteer**
**Application:** Allows consumers to access information regarding consumer goods and warranty packages

**Organization: Loyyal**
**Application:** Provides a platform in which smart contracts are used to analyze consumer spending data to create customized loyalty and rewards programs for retailers

**Organization: Provenance**
**Application:** Provide an open transparent digital record of inventory items for retailers

# Industry Applications of Blockchain:

Logistics/Supply Management

**Organization: BlockVerify**
**Application:** Provides anti-counterfeit solutions to verify and identify counterfeit products, diverted goods, stolen merchandise and fraudulent transactions

**Organization: Origin Trail**
**Application:** Tracks data throughout supply chains and inventory management systems for product and service verification, location whereabouts

**Organization: De Beers**
**Application:** Uses Blockchain Technology to trace diamonds throughout the supply chain in order to ensure authenticity of products

# Industry Applications of Blockchain:

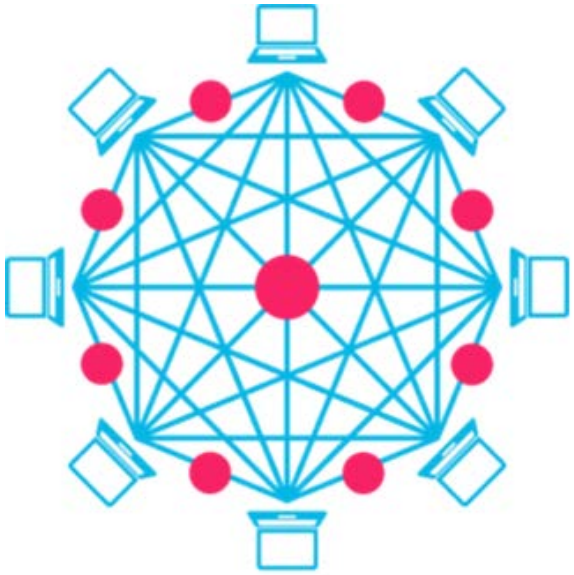
Insurance Industry

**Organization: Accenture**
**Application:** Provide Blockchain-based services to insurance companies to streamline the process of claims processing and risk assessment

**Organization: Nationwide Insurance**
**Application:** Provide proof-of-insurance information (RiskBlock) to assist law enforcement, policy holders and insurers verify insurance coverage in real time and accelerate claims processing

# Industry Applications of Blockchain:

Summary of Industry Use



**1.** Streamlining of payments processing and contract settlement

**2.** Ensuring the accuracy and accessibility of information

**3.** Validating the authenticity of products

**4.** Tracing products through supply chains

# Agri-Food Industry Applications of Blockchain

**Walmart**
- Tracing of products through supply chain (Mangoes & Pork)

**Cargill**
- Tracing of products through supply chain (Frozen Turkeys)
- Completion of an international shipment of Soybeans from the Argentina to Malaysia

**Louis Dreyfus & Co.**
- Completion of an international shipment of Soybeans from the U.S. to China

**Ripe**
- Start-up company using Blockchain to analyze data obtained from precision agriculture technology

**AgriDigital**
- Completion of an international shipment of grain from Australia to the U.S.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IBM

# Agri-Food Industry Applications of Blockchain

Dole

McLANE

Driscoll's

WAGENINGEN UNIVERSITY & RESEARCH

Unilever

Walmart

Nestlé

gsf golden state foods

Tyson

McCormick

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# Industry Applications of Blockchain:

Agri-Food Sector Uses: Summary

**1. Tracking of Products and Processes through Supply Chains**

- Food security, quality assurance, food safety
- Access to new markets (regulatory compliance)
- Meeting needs of large retailers (mandated use)

**2. International Trade and Payments Settlement**

- Reduction in information friction(s)
- Minimizing inefficiencies in international transactions
- Certificate authentication

**3. Data Management and Analysis**

- Information management
- Food safety, quality assurance

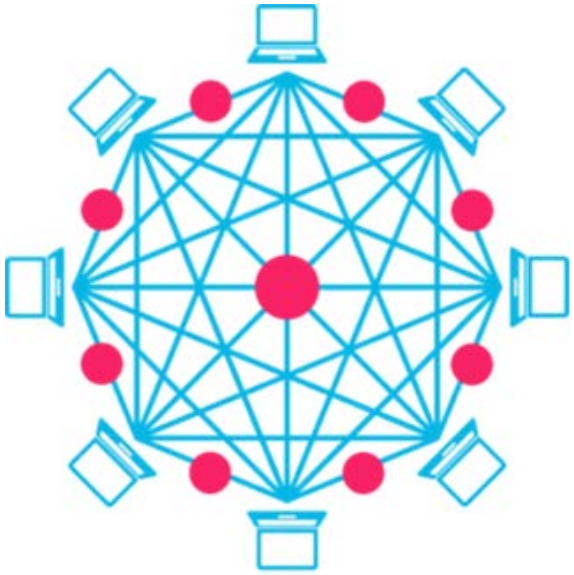
**4. Increasing Efficiency of Inventory Management Systems**

- Minimizing/reducing costs
- Identifying logistical inefficiencies
- Increasing transparency of product, process and information flow

# Blockchain in the Agri-Food Industry:

Is Blockchain Technology Needed?

Benefits to the Agri-Food Industry



**1.** Optimization of Inventory Management Systems

**2.** Payment Processing & Contract Settlement

**3.** Supply Chain Transparency

**4.** Enhanced Supply Chain Traceability

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# Potential Research Areas:

Motivations: Current Issues in Food Supply Chains

1. **Consumer trust issues**
2. **Supply chain transparency**
3. **Product quality**
4. **Logistics issues**
5. **Privacy of consumer data**
6. **Fraud and food safety**


# Potential Research Areas:

Motivations: Benefits of Increased Traceability (and Transparency) in Food Supply

## 1. Improving supply chain management

- Pinpointing high yield or high quality products
- Improving supply chain efficiency
- Lowering operating costs

## 2. Traceability for food safety and quality

- Increased firm reputation
- Decreased legal liability concerns
- Meeting mandated use imposed by large retailers

## 3. Differentiating and Marketing Products

- Added value to products
- Product differentiation
- Access to new markets

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# Proposed Research:

Methods

## Survey of Ontario Agri-Food Firms

- Analyze producer willingness-to-adopt Blockchain Technology
  - Understand what factors lead to adoption
  - Identify barriers to adoption
  - Identify applications

## Case Study Approach (Exporting firm)

- Examine the use-case of Blockchain Technology in a particular firm/industry
- Understand how Blockchain Technology can be used
- Extrapolate findings to Ontario's Agri-Food Sector

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# Research Challenges to Consider

1. **Challenge to obtain accurate estimates for costs and benefits**

2. **Wide range of Blockchain Technology applications**
   a) For which application will Blockchain be most widely used?

3. **Variation of existing traceability/information management solutions**

4. **Diversity of Ontario's Agri-Food Sector**
   a) Where will Blockchain make a difference?
   b) Where is Blockchain Technology best suited?

5. **Latency of Technology**

# Going Forward

**What problems currently exist in Ontario's Agri-Food Sector?**

- Food Traceability (Food Safety, Quality Assurance)
- High Transaction Costs/Information Asymmetry
- Access to (International) Markets
- Lack of Coordination between Intra-Industry Firms?

**Which industry/sub-sector is most prone to these issues?**

- What industry is best suited for the adoption of Blockchain Technology

**Where does OMAFRA see the value of Blockchain Technology?**

Ontario
Ministry of Agriculture, Food and Rural Affairs

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