

How blockchain can propel international trade and transform the food supply chain

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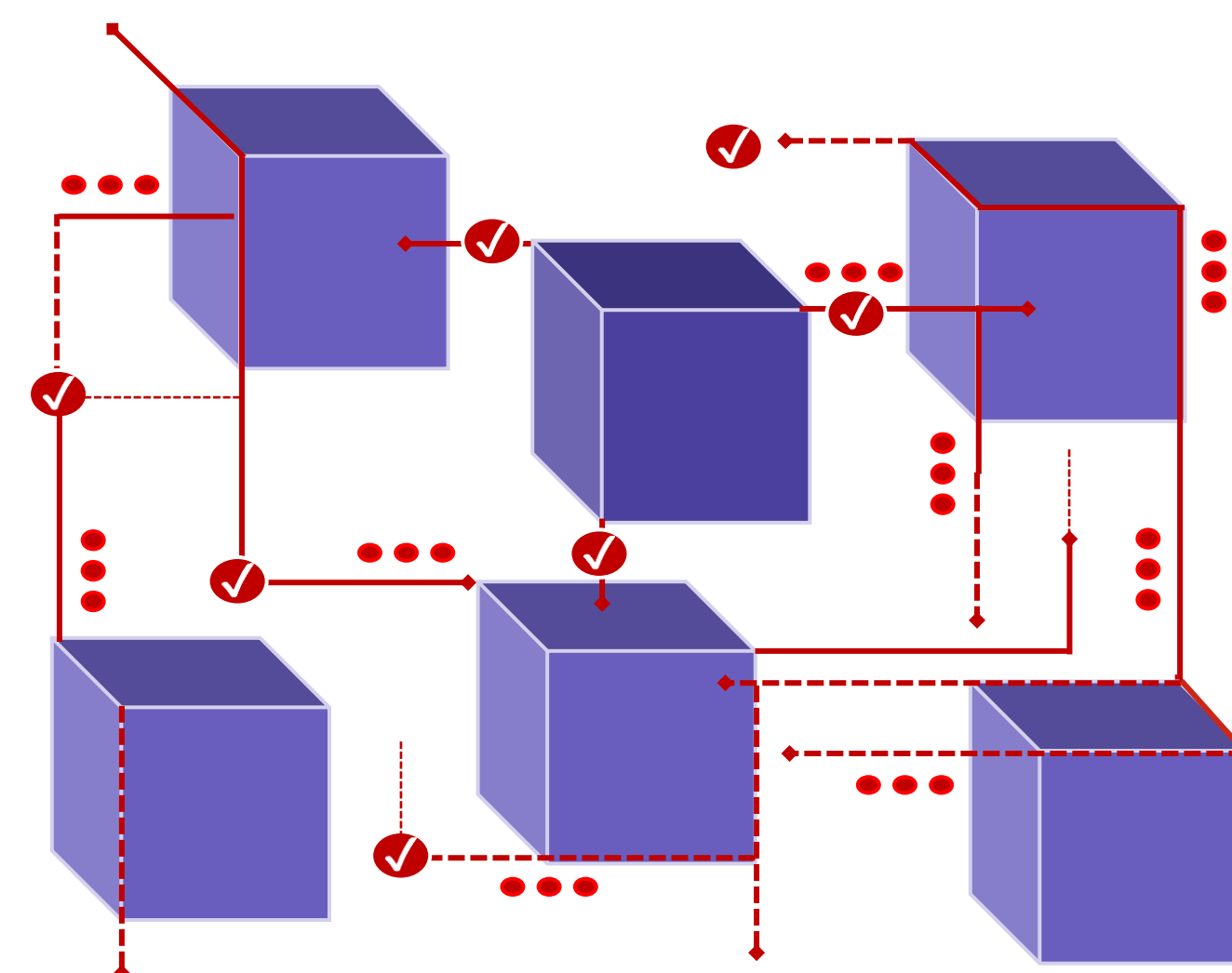
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1 Introduction: Overview of blockchain technology

Blockchain, created in 1991, is a decentralized technology that securely stores and timestamps digital records in a tamper-proof chain of blocks. It operates without intermediaries, using encryption and consensus mechanisms to ensure data integrity. Each block contains transaction details linked to the previous one, creating a transparent, secure, and immutable ledger. Blockchain enhances trust, reduces fraud, and enables automated transactions through smart contracts, making it ideal for decentralized applications and real-time data management.

Blockchain in the **food supply chain** ensures complete traceability of food-related data and multi-party transactions, enabling rapid tracking of food provenance in seconds instead of days. It streamlines verification of food safety and quality compliance while enhancing the security of supply chain data.



2 How does blockchain impact the food supply chain?

Challenges addressed:

- ✓ **Trust & integrity:** Ensures data authenticity and prevents fraud.
- ✓ **Transparency:** Provides clear visibility into transactions.
- ✓ **Food security:** Improves traceability and safety.

Scalability:

- ✓ **Global access:** Decentralized ledger supports large-scale operations.
- ✓ **Data consistency:** All participants access the same information.

Performance:

- ✓ **Error reduction:** Automates transactions to minimize errors.
- ✓ **Efficiency:** Speeds up processes with smart contracts.

Distributed consensus:

- ✓ **Data integrity:** Consensus mechanisms maintain an unchangeable ledger.
- ✓ **Fraud prevention:** Standardizes transaction steps to reduce errors.

Security:

- ✓ **Privacy:** Protects data with encryption and pseudonymity.
- ✓ **Access control:** Restricts data access to authorized users.

Cost-Effectiveness:

- ✓ **Lower costs:** Reduces transaction fees compared to traditional methods.
- ✓ **Streamlined operations:** Accelerates supply chain processes.

Supply chains struggle with challenges such as trust, integrity, and transparency. Blockchain addresses these issues by providing immutable data and enhanced visibility, as illustrated in **Figure 1**.

3 International trade, food value chains, and the blockchain technology

Global value chains (GVCs) in the agri-food industry face key challenges: high documentation costs, lack of transparency, and limited traceability. These deficiencies include managing the cost of documenting transactions, ensuring product quality, and addressing food safety concerns. **Blockchain technology can address these issues by providing immutable records and clear visibility.** However, there are hurdles to overcome, including the **need for international trade rules** to accommodate blockchain and ensuring that eco-labels and environmental standards are aligned with trade regulations. Blockchain could improve traceability, reduce documentation costs, and enhance compliance with international trade agreements, ultimately supporting more efficient and transparent agri-food supply chains.

4 Blockchain as a disintermediation technology in the food chain

Blockchain eliminates intermediaries by providing secure, transparent record-keeping among untrusted parties in the food supply chain.

It boosts trust, traceability, and efficiency, helping track products from farm to fork and reducing fraud.

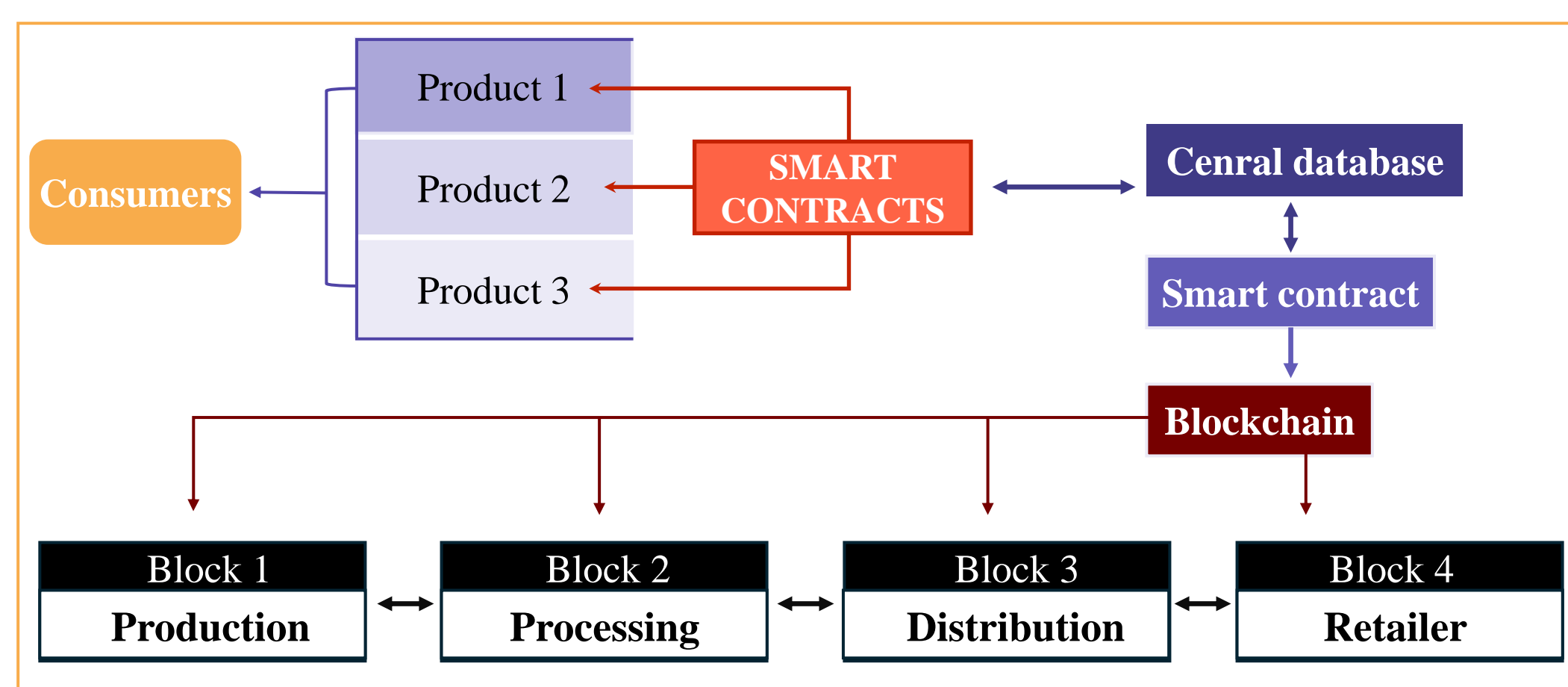


Figure 1. Structure of the food supply chain with the help of blockchain.

5 Technical and regulatory challenges in the food supply chain

Major challenges in implementing blockchain in the food supply are listed in **Table 1**. To address these, cost-efficient solutions such as shared blockchain platforms can reduce expenses, while training programs can bridge skill gaps. Flexible data management strategies can help mitigate immutability challenges, and data-sharing agreements can alleviate confidentiality concerns. Legal frameworks need to be developed to clarify the use of smart contracts.

Table 1. Summary of the technical and regulatory challenges in the supply chain.

CHALLENGE	DESCRIPTION
High costs	Expensive implementation and maintenance.
Limited expertise	Few specialists and high fees for blockchain technology.
Skill gaps	Insufficient training for farmers and supply chain participants.
Scalability issues	Difficulty in proving the technology's ability to scale effectively.
Data immutability	Challenges in managing unchangeable data impacting operations.
Lack of standards	No common standards, causing integration issues.
Confidentiality concerns	Resistance to sharing private information among competitors.
Cryptocurrency stigma	Negative image associated with cryptocurrencies.
Legal uncertainty	Unclear legal frameworks for smart contracts in food supply chains.

Conclusions

Blockchain enhances **transparency and traceability** in the food supply chain, improving **safety and consumer trust.**

Collaboration and proper infrastructure are key to implementing blockchain for a more **secure and sustainable food system.**

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