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Original Article

Blockchain in the Agricultural Marketing and Consumers' Trust

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Abstract

The potential of blockchain technology to reshape agri-food systems has gained traction as it can improve supply chain transparency, traceability and trust. Its decentralised ledger system facilitates more transparency, eliminates inefficienceis and fraud. The aim of this review is derive recent trends in blockchain-based applications to the agricultural marketing that impacts consumer trust. The paper takes a multidisciplinary approach to discuss the theory, models and practical method underpinning Blockchain adoption in agriculture. It analyzes examples from all over the globe to learn what this technology means for the different players involved — be there farmers, traders, retailers or consumers. The paper also discusses policy implications, strategic insights and future research directions which could facilitate the deployment of blockchain technology to agriculture in order to create a more inclusive, transparent and efficient food system.

Keywords

Agri-Food, Decentralization, Food Safety, Supply Chain, Traceability, Transparency

Introduction

Agriculture continues to play a key role in the global food security and economic stability, especially in developing countries where significant part of their societies rely on farming. However, the conventional mode of marketing systems are beset with several problems-ineffective transport systems, fluctuating prices, impurities and fraud are only some of them. Not only do these problems eat into the profits of farmers, but they also undermine consumer confidence, particularly about food safety and origin.

The modernization of agriculture is increasingly dependent on technology as we progress in to the 21st century. Blockchain, a decentralized way to securely record and share data, is one of the most potentially disruptive innovations. From product traceability and certification to smart contracts and the overall stream providing efficiency, blockchain is fundamentally transforming how agri-products are marketed and trusted.

A major obstacle in agri-food systems is loss of trust among producers, intermediaries and consumers. With increasing conflicts over ethics in sourcing food and ensuring it is authentic, consumers are demanding evidence. In fact, work done by Maesano et al. (127) shows that some 70% of consumers in developed countries make their food

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purchases depending on the traceability. Blockchain provides a solution by allowing full transparency into the journey of a product (from farm to shelf), including information on its origin, transport, chemical treatments and certifications.

Products are traded via many intermediaries before they reach the end customer, thus, posing multiple occasions of inefficiencies and fraud. Blockchain contributes by furnishing one trustworthy record that all parties can turn to. This transparency cuts down on gamesmanship, creates consistency in data and trust between farmers and eaters—all of which changes not just the way the marketing end works but how relationships work.

Both governments and private companies are now supporting blockchains to better link smallholders into formal supply chains. About Not a pilot anymore IBM Food Trust AgriDigital India's eNAM blockchain network and many others are no longer just pilot projects but they're already showing results. These systems have increased the income of farmers, reduced transactions costs, and given confidence to consumers in certified products such as organic vegetables, fair-trade coffee and halal meat (Balusamy 2025; Hidayati et al. 2025).

At the end of the day, blockchain goes beyond simply digitizing transactions – it enables access to trusted, shared information across the agricultural value chain. But in order to achieve success, its use will have to be enabled by adequate policies, digital infrastructure and education as well as inclusive frameworks that prevent small-scale farmers getting left behind in this digital transformation. This paper investigates the way in which blockchain meets agricultural marketing and consumer trust theory, practice, and real cases. It intends toâ€"Assess the potential of blockchain in agriculture â€" Opportunities and challenges of using this technology in food supply chains so that they serve multiple purposes: to build trust, ensure product traceability and encourage sustainable growth.

Theoretical Framework

It is not possible to understand the function of blockchain in agriculture without associating some theoretical aspects, which are related with economics, information systems, institution design and behavior science. Here are some of the key theories that can account for how blockchain increases transparency, diminishes information asymmetry and makes trust.

A. Agency Theory

The agricultural value chain is usually a principal-agent system. Here, farmers or traders act as proxies for consumers, but the asymmetry of information can invite mistrust and shifty practices — like spraying unapproved pesticides without revealing it or misreporting storage conditions.

Blockchain makes such a threat less likely, since it records each move in a secure and unalterable fashion. It is all recorded and visible to everyone, whether it's the pesticide you used or what temperature you stored something at as you took it from A to B. This openness assuages fears of secretive behavior and fosters trust. Research by Consolaro et al. (2025) and Khan (2025), blockchain ensures primary on confidence in product authenticity and certification.

B. Institutional Theory

This theory explores the impact of status quo systems, norms and regulations upon the take up of new technologies. In agriculture, marketing is frequently influenced by venerable institutions such as cooperatives, regulators or big agribusiness. Such descendants may support or oppose change.

Institutional support makes adoption easier for a technology to start with. For instance, India's adoption of blockchain in National Agricultural Market was due to good government support (Arogundade & Njoku 2025). In Europe, traceability-related food legislation has been implicated on the adoption of blockchain by food producers in Spain and Italy (Consolaro et al., 2025). The technology tends to be copied by a number of organizations once it is introduced, in order to remain competitive. As soon as major brands lead the way, others will probably race to keep up in order not to lose market share and consumer confidence.

C. Technology Acceptance Model (TAM)

The Technology Acceptance Model, (created by Davis 1989) describes how users accept and use new technologies. It suggests that an individual's intention to use a technology is influenced by the two main contributing factors, perceived usefulness (PU) and perceived ease of use (PEOU).

When used in innovation in blockchain for agriculture, TAM both interprets farmers and consumers' behavior:

Farmers may be reluctant to take on blockchain platforms if they find them too complex or not useful for income earning. Consumers will only believe in products labelled by blockchain if the information is clear and available, such as through QR codes on packaging. Some recent works (e.g., Theocharis & Tsekouropoulos, 2025) find that the trust in

blockchain food products among consumers would get a positive influence by information clarity and users' digital literacy.

D. Trust Theory and Signaling Theory

In markets characterized by weak verifiability, signaling theory studies the extent to which sellers signal quality through identifiable characteristics or certifications. Blockchain provides a credible signal that the product meets certain standards. Also, unlike for regular certifications (which can be easily faked or altered), blockchain records are stored in a shared distributed ledger and cannot be deleted.

Trust theory also applies here. The other form of trust – reputational-based trust – emerges from a combination of reputation, common norms and transparency. Blockchain promotes trust by offering:

- Inter-temporal consistency of data
- Decoupling of consensus mechanism (avoiding single point of failure)
- Openness of verifiability; rather than checking forentially these facts at retail level, consumers retro-validated claims (Dang et al., (2025)

Trust is an essential factor in consumer purchase behavior particularly towards products such as organic products, halal food and fair trade product (Hidayati et al., 2025).

E. Resource-Based View (RBV) of the Firm

In terms of agri-tech innovation, companies or cooperatives with blockchain technology can build a sustainable competitive advantage. As per the resource-based view, resources with unique and un-replicatable value thus a trusted blockchain traceability solution can result in strengthening of firm's position in the market. Food sector early adopters such as Walmart with pork trace-ability in China have shown that for blockchain, benefits go beyond internal efficiencies to also stoke external brand reputation.

F. Stakeholder Theory

It is well established that agricultural systems have multiple players — farmers, input providers, regulators, processors, distributors, retailers and consumers. There are various participants in agriculture: farmers, regulators, processors, suppliers, distributors and consumers. According to the stakeholder-theory, the demands and needs of all these parties should be respected. Blockchain is the shared environment in which everyone has access to clear, seamless data. Studies by Malavathula et al. (2025) and Maesano et al. (2025) argue that the involvement of stakeholders is critical in shaping blockchain adoption. When it benefits everyone to have transparent systems, implementation is likely a lot easier.

Conceptual Framework

In order to consider the role of blockchain in agricultural marketing and consumer confidence, we do develop a framework composed by four interconnected categories:

A. Overview of the Framework

- Blockchain Infrastructure
- Agri-Food Supply Chain Processes
- Information Transparency and Trust Mechanisms
- Consumer Outcomes and Market Responses

These elements also have a circular, feedback relationship: the use of blockchain provides promise trust and increases demand for certified product.

B. Components of the Framework

a) Blockchain Infrastructure

This foundational layer includes:

- DLT: Descentralized, assured and irrevocable ledger for recordkeeping of agricultural transactions.
- Smart Contracts: Automatically make deals such as by paying the farmer upon delivery confirmation.
- IoT Integration: Solutions like GPS and sensors help in getting the real-time data on the field.
- Identity Solutions: Enable verification of identities and credentials such as farmer registration, buyer identification.

For example, the smart contracts in India's eNAM platform automatically fulfil payments to farmers once their delivery of produce has been confirmed digitally (Arogundade & Njoku, 2025).

b) Agricultural Supply Chain Processes

Blockchain impacts various stages:

- Production: Tracking of inputs such as seeds, fertilizers and water usage for traceability.
- Harvest and Processing Real-time capture of post-harvest handling, grading and storage practices.
- Distribution and Logistics: At every logistics node, temperature, transit time, and storage location are recorded.
- Retail and certification: QR codes on packaging enable North American consumers to trace a product's origin, handling, and certifications (organic or halal).

Example: Consolaro et al. (2025) reported that olive oil in a blockchain labeling system led to an 18% increase in consumer willingness to pay as a result of traceable origin and ecological certifications.

c) Information Transparency and Trust Mechanisms

Blockchain generates trust through:

- Immutability of Data- Preserving data duration immutability means that recorded data cannot be modified or deleted.
- None of those actors is solely in control of the data, so manipulation risks are minimized.
- Open Verifiability: End users are able to verify product histories autonomously.
- Reputation Networks: Providers The presence of reputation systems provides credibility to suppliers and trust based relationship in an enhanced way.

For instance, in the IBM Food Trust customers scan QR codes to get harvest-to-retail data on pork and leafy greens, elevating their confidence in food safety (Balusamy, 2025).

d) Consumer Outcomes and Market Responses

The ultimate results of blockchain-backed marketing are such:

- Greater Consumer Confidence: Enhanced trust in statements such as "organic, locally grown and non-GMO."
- Will Pay a Premium: Shoppers are willing to pay more for proof of quality.
- Brand Loyalty and Differentiation: Retailers who operate on blockchain create a competitive advantage by offering transparency.
- Less Food Fraud: Chain of custody discourages fraud, such as adulteration, falsification and counterfeiting.

Example: Maesano et al. (2025) evidence on blockchain traceability for pasta that showed counterfeit labels were decreased by 27% in Italian exports.

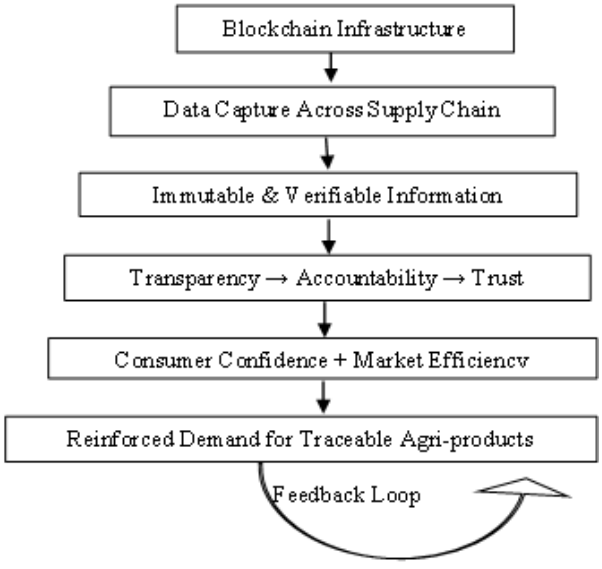

Figure 1: Conceptual Framework

C. Cross-Cutting Influences

Table 1: Cross-cutting influences

Factor	Role in Framework
Government Regulation	Ensures legitimacy and standardization of blockchain records
Stakeholder Collaboration	Data accuracy depends on farmer, transporter, processor, and retailer participation
Digital Literacy	Affects usability for both producers (data input) and consumers (data interpretation)
Platform Design	User-friendly interfaces and mobile access drive adoption and trust

This construct reminds that blockchain is not just a technology but the architecture of trust. It turns black-box supply chains into clear, open systems. It must be successfully appropriated to technology, regulation, stakeholders, and public opinion.

The model also stresses the synergy between technology credibility and market confidence. With the growing trust, demand for authentic products also keeps increasing and this gives an even bigger boost to Blockchain marketing integration.

Methodology

In order to gain an integrated understanding surrounding the role of blockchain technology in agricultural marketing and its effect on consumer trust, this review adopts a structured systematic methodological approach by integrating three techniques: qualitative synthesis, comparative content analysis and evidence triangulation across peer-reviewed literature, grey literature as well as industry reports.

A. Research Design

Instruments and Research Design This study uses a qualitative integrative review design appropriate for synthesizing research from a variety of fields including agricultural economics, information systems, food marketing-economic theory/concepts instrument development measurement consumer behavior 421 supply chain management. The integrative review approach facilitates:

- Identification of common themes
- Discussion of theoretical and practical implications of findings
- Synthesis of interdisciplinary perspectives

B. Data Sources

To make sure the credibility and applicability of this review, information were adopted by five core sources within academic and industry literatures:

Table 2: Data sources

Database / Source	Access Points
ScienceDirect (Elsevier)	Peer-reviewed journals on food systems & marketing
IEEE Xplore	Blockchain architecture and agri-IoT technologies
SpringerLink	Sustainable agriculture and traceability systems
ResearchGate	Working papers, conference proceedings
Scopus/Google Scholar	Citation-based filtering for high-impact research

Reports from international organisations – Food and Agriculture Organization (FAO), World Bank, IBM Food Trust were also reviewed for empirical examples and approaches.

C. Search Strategy

A 2-phase systematic keyword search was conducted between January to May 2025 for articles published in 2020-2025 to gather the most recent trends and developments.

D. Phase 1: Keyword Filtering

Primary keywords used:

- “Blockchain AND Agriculture”

- "Blockchain AND Agricultural Marketing"
- "Blockchain AND Consumer Trust"
- "Food Supply Chain AND Traceability"
- "Smart Contracts AND Agri-Food Systems"

Boolean operators and, or, not were used to combine queries and narrow results.

E. Phase 2: Inclusion/Exclusion Criteria

Table 3: Inclusion/Exclusion criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2020 and 2025	Articles before 2020
Peer-reviewed or indexed journals	Blog posts or opinion pieces
Studies in English language	Non-English literature not translated
Empirical, theoretical, and case-based studies	Purely speculative or non-agriculture-focused tech
Relevant to blockchain, agri-marketing, or traceability	Studies limited to crypto finance applications

43 sources were found in the initial filtering. After reading the titles and abstracts, deduplicates were removed and 20 peer-reviewed sources in addition to 5 institutional reports remained for full analysis.

F. Analytical Framework

The included literature was analyzed applying thematic content analysis and informed by the following procedure:

- Open Coding – Blockchain advantages, applications, and implications keywords were identified.
- Classification – Key codes were classified to groups on again such as "traceability", "trust mechanisms", "marketing efficiency" and also "consumer behavior".
- Theme Generation —The categories were used to generate higher-level themes such as "Technology as Trust Infrastructure" and "Decentralized Transparency in Food Systems."
- Triangulation – Data collected from the academic literature was compared with examples of cases in practice (industry) to improve trustworthiness and generalisability.
- Furthermore, a table of comparisons between studies was compiled in order to evaluate geographic focus, technology maturity, and results across the studies.

G. Case Study Selection

To provide an overview of the practical implementation and perception of blockchain, we have identified and summarised seven regional case studies that were described in the literature:

Table 4: Case study selection

Country / Region	Application Area	Source
India	eNAM blockchain for farmer traceability	Arogundade & Njoku (2025)
Vietnam	Fine dining food provenance	Dang et al. (2025)
Italy & Spain	Olive oil traceability and labeling	Consolaro et al. (2025)
China	Pork and leafy vegetable tracking via IBM Food Trust	Balusamy (2025)
Indonesia	Halal certification systems in agri-food	Hidayati et al. (2025)
Nigeria	Farmer cooperatives and smart contract transactions	Malavathula et al. (2025)
EU	Organic certification and consumer labeling systems	Maesano et al. (2025)

Source: Authors' own synthesis, 2025

H. Limitations of Methodology

Although the present review is trying to be broad and deep, there are some shortcomings:

- Geographic Coverage: There is an underrepresentation of research from Africa and Latin America; there is restricted publication in English.
- Publication Lag: Blockchain research has been progressing at such a pace that traditional, peer-reviewed academic articles will always lag behind real-world practice.
- Absence of Quantitative Meta-Fusion: Despite thematic abundance, the review refrains from statistical meta-analysis because of metric heterogeneity.

I. Ethical Considerations

Since this is a litericture-based review, it does not involve human participants and did not require ethical approval. All references have been properly cited and no copyrighted or propriety data were included beyond fair academic use.

Results and Discussion

This section reports on the main results of the literature review, shedding some lights on how blockchain has been implemented within agri-food systems and how these uses impact marketing outcomes as well as consumer trust. Based on 25 high-quality sources from the global South and seven cases studies, we identify five significant thematic areas:

A. Application to Supply Chain Trackability and Marketing Efficiency

Based on the preceding reports, traceable systems and marketing efficiency may be enhanced by blockchain technology.

End-to-end traceability is the most frequently claimed advantage of using blockchain technology in agriculture. In various specific use-cases case-studies, blockchain technologies have been mustered to record every vital step in the agri-food supply chain – from planting seeds to selling product – generating a transparent digital trace.

For example:

- Through the IBM Food Trust platform, Walmart and Carrefour were able to cut food traceability for vegetables from days (7 days) to 2.2 seconds (Balusamy, 2025).
- In India, the eNAM blockchain solution has reduced transaction times and enhanced price transparency for smallholder farmers, leading to farmgate price increases of 10–15% (Arogundade & Njoku, 2025).

These gains are easily translatable into marketing efficiency. Producers differentiate their products with verified quality using blockchain, giving a path to D2C strategies and premium pricing.

B. Consumer Trust: Blockchain as a Stimulus

Trust echoes through all the reviewed literature. Consumers are also looking for greater transparency on the origin of food, how it has been sourced and whether it is safe to eat. Blockchain addresses this need in the following three ways:

- Data Integrity: Immutable records mean that it is more difficult to lie about claims such as “organic” or “non-GMO”.
- Verifiability: Shoppers can scan a QR code to view the history of products — from where they were farmed to how they were transported.
- Cutting Out Mediators: Trust is established by a decentralized mechanism rather than by third-party certifiers.

Notably:

- Consolaro et al. (2025) when olive oil products were provided with blockchain provenance claims, it lead to an 18% increase in WTP for consumers.
- A study by Maesano et al. (2025) Selective: Pasta consumers were 27% more likely to trust packaging that is supported by blockchain traceability.
- These results confirm that blockchain builds not only product authenticity but also brand identity and consumer trust.

C. Specific Application in Halal, Organic and Ethical Supply Networks

Blockchain is especially valuable in markets where trust is crucial — such as for halal, organic or fair-trade goods.
For instance:

- In Indonesia, however, blockchain is being used to confirm that meat processing conforms to halal standards and could boost the confidence of both domestic and international buyers (Hidayati et al., 2025).

- The role of blockchain in maintaining the cultural authenticity in food systems is also demonstrated by Theocharis and Tsekouropoulos (2025), especially where certification has typically lacked transparency.
- These applications illustrate how blockchain can enable ethical consumption by inscribing religious, environmental, or social being- in and compliance into the product's digital inscription.

D. Adoption Barriers Infrastructure, Cost and Digital Divide

The interests are self-evident, but obstacles remain. The drivers of blockchain adoption is an important topic in many researches and there are:

- High Cost: Development and launch of blockchain solutions (particularly non-public permissioned ledgers) entail massive capital outlay.
- Digital Infrastructure Gaps: Much of the rural farming areas do not have internet, IOT sensors or mobile devices to input data in real time.
- Digital Literacy Lack of digital literacy: lack of skills among farmers and cooperatives to use blockchain applications, especially in LMICs.
- Scalability Public blockchains have slow transactions and high energy consumption.
- Ranjana (2025) found that mobile application access to blockchain-enabled traceability scaled to the national platform level, but only ~23% of Indian surveyed farmers made use of it.
- Thus, blockchain may risk (a) being "top-down" in its adoption unless it is coupled - with capacity building initiatives, mobile-enabled platforms and infrastructure subsidies.

E. Real-World Case Study Synthesis

Real world application of blockchain in agri-marketing: it's not just theoretical. The review finds seven high-impact cases, including full and partial extent of application:

Table 5: Case Studies

Region/Country	Application	Outcomes
India (eNAM)	Farmer marketplaces with blockchain traceability	Improved price realization, faster transactions (Arogundade & Njoku, 2025)
Vietnam	Blockchain for gourmet food in high-end restaurants	Enhanced brand reputation, premium pricing (Dang et al., 2025)
Italy & Spain	Olive oil provenance systems	Increased consumer trust and traceability verification (Consolaro, 2025)
China	Blockchain for pork traceability via IBM Food Trust	Reduced food safety incidents, improved recall precision (Balusamy, 2025)
Indonesia	Halal blockchain certification systems	Real-time compliance and trust in religious markets (Hidayati, 2025)
Nigeria	Smart contracts for farmer cooperatives	Transparent payment mechanisms, fewer intermediaries (Malavathula, 2025)
EU (Generic)	Organic labeling backed by DLT	Boost in consumer confidence and policy support (Maesano et al., 2025)

Source: Authors' own synthesis, 2025

Conclusion

Blockchain has emerged as a disruptive technology in the agricultural sector, especially in the areas of marketing and consumer involvement. As described in this review, the key characteristics of blockchain: decentralization, transparency, immutability and real-time access to information are inherently well-suited for many challenges within agri-food systems such as : supply chain opacity, consumer mistrust, inefficient market linkages and food fraud.

Results across reviewed literature and case studies continuously show that blockchain enriches traceability, boosts consumers' confidence in quality food products and has the potential to increase efficiency and fairness in agricultural marketing. More important in a post-pandemic world economy, where consumers are even more aware of food safety, ethical traceability and sustainability – just as farmers and producers want to receive a more fair share of the market.

A. Key Takeaways

- Trust and Technology: Blockchain is a digital trust layer. By offering a transparent and immutable record of where food came from, how it was treated during production process and if it has reached by below the standard route provides confidence to consumers and strengthens brand reputation.
- Digital Trust: Blockchain serves as a trust layer to make food claims credible for consumers.
- Freelance Farming: Smart contract and direct-to-consumer platforms enable farmers to bypass middlemen, bargain for fair prices, and access the kind of premium markets.
- Honest Marketing: Featuring blockchain, brands can tell true narratives of their products (with data to support it).
- Policy Coordination: Efforts such as those by India (eNAM) and China to pilot blockchain show the need for a supportive institutional and policy environment.
- Bridging the Digital Divide: There is a need to invest in people and infrastructure, share capabilities as well as enabling access for small farmers.

B. Foresight for Agri-Blockchain

Although still in its early days, blockchain is certainly being woven into the future of food. It underpins data-informed, open and consumer-oriented models. But in order to be successful, it must also be accompanied by technologies such as IoT, AI, mobile platforms, and ethically sound data practices. It must also be inclusive —created with the needs and limitations of smallholders in mind.

Ultimately, blockchain is not another tech fix; instead it is a key to reimagining governance, accountability and trust in the food system. The trick is ensuring it is deployed in ways that are fair, scalable — and driven by genuine collaboration.

Recommendations

A coordinated effort is required to realize the value of blockchain in agriculture. These recommendations are addressed to policymakers, tech developers, farmers, researchers and international organizations — everybody involved in renovating an agriculture we can trust.

A. For Governments and Policymakers

a) Create National Blockchain Strategies in Agriculture

Develop clear roadmaps for how blockchains can be useful across multiple parts of the agricultural value chain that are tailored to national priorities and challenges. This includes:

- Encouraging[sic] pilot programmes in traceability and smart contract based agricultural procurement.
- Adoption of technical specification and interoperability rules.
- Establishing a regulatory sandbox for agri-tech blockchain innovation.

b) Invest In Rural Digital Infrastructure

Rural broadband, mobile networks and IoT sensors need to be an investment priority for real-time data entry and access to blockchain applications. Without it, blockchain will continue to be territorial and exclusive.

"Support the access of smallholders to blockchain platforms."

Provide incentives in the form of targeted subsidies, tax exemptions or co-funding to cooperatives and agribusinesses who onboard small-scale farmers into blockchain ecosystems. This would include cascading QR code labeling systems and mobile traceability apps in local languages.

B. For the Agri-Tech Startups and Platform Developers

a) Design User-Friendly and Mobile-Compatible Platforms

- Applications that use blockchain should be made for low-literacy and low-connectivity settings. Voice-enabling, icon-driven navigation, and SMS-capable systems could greatly improve accessibility for smallholders.

b) Integrate Blockchain with Other Technologies

- Integrate blockchain with IoT (for automated data logging), AI (for anomaly identification) and geospatial solutions (farm mapping). The credibility and usability of the blockchain records is further improved with a hybrid approach.

C. Open APIs and Interoperability

- This fragmentation can be avoided if a majority of the developers focuses on open-source standards, and associated APIs that (at least in theory) allow different blockchain ecosystems to interact like private vs public ledgers, or local vs global markets).

D. For Cooperatives and Farmers' Organizations

a) Capacity Building in Digital Literacy

a) Arrange some knowledge-sharing workshops for members concerning the basics of this new blockchain, what it can do and how they might become familiar with traceability apps or digital wallets. Education of farmers is a key to adoption.

b) Promote Cooperative-Led Traceability Initiatives

- Harness the combined power of coops operating group-wide blockchain systems to trace produce through from shared warehouse/processing unit to market.

c) Document Best Practices for Transparency

- Farmer associations should take the lead by documenting and making available auditable records of input use (organic or fair trade certified) along with other certification and good practice standards thereby strengthening consumer confidence.

E. Consumers and Retail Chains

b) Promote Blockchain-Labeled Products

- Retailers would be well advised to actively market products with blockchain certification, for example by means of labels at the shelf, digital interfaces or applications that are adapted to QR code scanning in order to serve consumer needs and enhance their shopping experience.

c) Train Consumers to Read Traceability Data

- Create awareness to educate consumers on how they should analyze product histories through blockchain. An increasingly educated consumer class will also be increasingly likely to expect and appreciate all manner of traceable products.

F. For Development Agencies and NGOs

a) Promote Inclusive Blockchain Pilots in LMICs

- Multilateral institutions (e.g., FAO, IFAD, World Bank) should finance and assess blockchain pilots aimed at women farmers, Indigenous populations and climate-resilient agricultural systems.

b) Develop Public–Private–Community Partnerships (PPCPs)

- Form tri-sector collaborations to ensure that blockchain systems are not solely profit-driven but aligned with public good outcomes like food security, sustainability, and equity.

c) Create Global Knowledge-Sharing Platforms

- Create dossiers of Block-Chain case studies, design templates and success/failure analysis kits which practitioners can draw upon across nations practice after adapting to their individual context.

G. Academic and Research Institutions

a) Conduct Interdisciplinary Research

- Support interdisciplinary research to study the social, economic, technical, and ethical aspects of blockchain applications in agriculture.

b) Develop Blockchain Impact Metrics

- Normalize tool development to assess the impact of blockchain adoption on indicators pertaining to trust, market access, profitability and sustainability in agri-food systems.

c) Facilitate Participatory Research

- Involve farmers, retailers, consumers and government as co-designers/critics of blockchain solutions.

Policy Implications

Blockchain applied to the agricultural industry and transcendent in building consumer trust — implications for agricultural policy, data governance, market regulation, technology inclusivity. Public policy is not only a facilitator, but

also a pre-requisite for the scalable, equitable and sustainable adoption of blockchain technologies in agri-food systems.

A. Data Ownership and Governance

a) Establish Farmer-Centric Data Rights Frameworks

As blockchain powers the collection and storage of granular agricultural data (e.g.,input use, harvest date, certifications), the question of ownership over this data looms large. Farmers as principal data owners, and recognition of:

- Clear consent protocols
- Transparent data-sharing agreements
- Governance mechanisms for inclusion/exclusion in blockchain systems
- Check Data Colonisation by Agri-Tech Giants

Regulation needs to prevent all this stuff from falling into the hands of increasing monopolies by big business. There is a need to insulate a decentralized data world from being weaponized as an instrument of digital extraction and captivity.

B. Legal and Regulatory Reform

a) Recognize Blockchain Records as Legal Evidence

- To backstop outcomes of blockhain-based transactions such as smart contracts or certifications, however, some legal reform will be necessary to establish that digital ledger entries are admissible records in disputes, trade audits and all types of compliance checks.

b) Revise Food Labeling and Traceability Statutes

- Regulations on food will also need to change, in order to support blockchain-verified labeling system: standard labels, such as “organic,” “halal” or “fair trade,” could be replaced by QR codes (or other unique identifiers) that link back to the underlying blockchain.

c) Provide room for regulatory sandboxes on Agri-Blockchain Pilots

- Regulatory sandboxes—experimental spaces in which blockchain startups can try out apps for agriculture without the stigma of undue compliance demands—should be built by governments. Those can serve to make it easier to evaluate risks and benefits in a real-world context.

C. Investment in the Development of Digital Infrastructure by Public Sector

a) National Rural Connectivity Missions

Even though the blockchain, by design, demands in-the-moment data capture and access, governments will need to focus on digital infrastructure as part of rural development policies:

- Rural broadband access
- Mobile penetration
- Affordable smart devices for farmers
- Support for IoT-based agri-sensors

Some countries such as India, Kenya and Brazil can improve already existing e-agriculture programs and incorporate blockchain attributes into them.

D. Motivation for Blockchain Adoption in Agri-Markets

a) Incentives and Credits for Farmer Enrolment

- Implement grants to onboard blockchain in the form of tax credits, concessional technology kits for smallholders and cooperatives who go into traceability and Blockchain marketing systems.

b) Green and Ethical Procurement Schemes

- Government procurement schemes (e,g, school feeding programs, food reserves) should prioritise suppliers who utilize blockchain-enabled traceability, creating incentives for transparency and ethical supply at scale.

c) Certification Fast-Tracking

- Provide expedited regulatory or lower costs for products certified on the blockchain – particularly organic, halal and export quality ones – as incentives that reward transparency.

E. Technical and Interoperability Standards

National and Regional Standards of Blockchain Develop direct or municipal-level regulations on the use of blockchain.

Without standardization, blockchain adoption can create disparate systems that do not speak to each other. Policymakers must:

- Implement national standards for the traceability fields (GPS coordinates, pesticide history, batch ID)
- Work with international organizations (i.e., ISO, Codex Alimentarius) to ensure harmonization is possible across countries.
- Mandate Interoperability for Government-Supported Platforms

State-backed blockchain platforms (e.g., for exporting agricultural goods) should be compatible with private sector systems and digital ID registries to facilitate open data sharing.

F. Capacity Building and Institutions Strengthening

a) Integrate Blockchain With Extension Services for Agriculture

- Blockchain education should be integrated into agricultural extension training packages to develop capacity of farmers, agri-preneurs, and rural development officers.

b) Support Research and Innovation Hubs

- Set up innovation labs in agricultural universities and research institutes for blockchain applications in food traceability, marketing, and supply chain optimization.

c) Develop Organization Readiness in Certification Bodies

- Regulatory, and certifying bodies (e.g., food safety, halal council, organic certifiers) should train for blockchain enabled audit system to transform from paper-based to digital compliance.

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