BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

MINI PROJECT SYNOPSIS

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Project Title:	Blockchain-Based Supply Chain Transparency for Agricultural Produce
Project Execution Place (Inhouse /Industry (Details of The Industry and External Guide (Name, Designation, Mail-Id, Contact No, Acceptance Letter to be enclosed))	Inhouse
Project Category/Area(Research, Environmental and Societal, Product development , Industrial Live Project, Application Project, Case Study)	Environmental and Societal Product Development

Mapping the mini project to mentioned SDG goals **1. No poverty** **2. Zero hunger** **3. Good health and well-being** **4. Quality Education** **5. Gender equality** **6. Clean water and sanitation** **7. Affordable and clean energy** **8. Decent work and economic growth** **9. Industry, innovation and infrastructure** **10. Reduced inequalities** **11. Sustainable cities and economies** **12. Responsible consumption and production** **13. Climate action** **14. Life below water** **15. Life on land** **16. Peace, justice and strong institutions** **17. Partnership for the goals**	1. No poverty 2. Zero Hunger 8. Decent work and economic growth 9. Industry, innovation and infrastructure 12. Responsible consumption and production 16. Peace, justice and strong institutions
Impact Areas: **1. Societal Impact** **2. Economic Consideration** **3. Environmental Context** **4. Health & Safety** **5. Legal & Ethical Framework** **6. Cultural Relevance**	1. Societal Impact 2. Economic Consideration 3. Legal & Ethical Framework

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Abbreviations : Expanded for the first use
(1 paragraph not more than 300 words)

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Body : Font : Times New Roman ,Font Size : 12,Spacing 1.5 Lines.
Figures & Equations : Captioned and Numbered.
Abbreviations : Expanded for the first use]

Abstract

This project proposes a blockchain-based system to track agricultural produce from farm to consumer, aiming to ensure transparency in pricing, quality, and origin. By leveraging decentralized ledger technology, the platform allows farmers, distributors, and retailers to securely record and verify each transaction, reducing fraud and exploitation in the supply chain. The solution integrates smart contracts for automated tracking and QR code-based access for consumers, enabling them to trace produce in real time. Designed with a user-friendly interface and deployable on low-cost hardware or cloud infrastructure, this system promotes fair pricing, accountability and trust across the agricultural ecosystem.

Introduction

Blockchain is an emerging technology that provides a decentralized, secure, and tamper-proof way of recording transactions. Unlike traditional centralized systems, blockchain operates on a distributed ledger where every transaction is verified by multiple participants, ensuring transparency and trust. Each record, stored in a block and linked to the previous one, makes the system resistant to tampering or fraud. Beyond finance, blockchain has found applications in diverse sectors, including healthcare, logistics, and especially agriculture. In the agricultural supply chain, blockchain can ensure that every step—from the farmer to the consumer—is recorded and verified, enabling greater transparency, fair pricing and accountability.

Existing System – Literature Survey

Paper (Author, Year)	Technology	Region	Focus crop / product	Key features / findings (simple content)
Lv et al., 2023 — *Blockchain-Based Traceability for Agricultural Products.* (MDPI)	Blockchain (survey)	Global (literature)	Multi-crop / general	Systematic literature review. Categorizes traceability solutions, shows blockchain provides tamper-resistant provenance and recommends hybrid on-chain/off-chain storage for large data.
Zheng et al., 2023 — *Blockchain Traceability Adoption in Agricultural Supply Chains.* (MDPI)	Blockchain + economic modelling	Global (theoretical)	Multi-crop / agri products	Uses game-theory / simulation to study incentives for adoption — finds incentives/governance and subsidies strongly affect farmer/processor adoption.
Ellahi et al., 2024 — *Blockchain-Driven Food Supply Chains: A Systematic Review.* (MDPI)	Blockchain + IoT (review)	Global (literature)	Food supply chain, general	Reviews IoT+blockchain integration; highlights improved traceability and faster recalls, but stresses the "oracle" problem (input trustworthiness).
El Hajji et al., 2024 — *Optimization of agrifood supply chains using Hyperledger Fabric.* (ACM Digital Library)	Hyperledger Fabric (implementation)	Case studies / simulation	Agri-food supply chains	Proposes Fabric-based design patterns for agri supply chain; shows performance benefits and access control advantages of permissioned ledgers.
Li et al., 2024 — *Design of agricultural product traceability system based on blockchain & RFID* (Sci Rep). (Nature)	Blockchain + RFID + centralized DB hybrid	China (implementation)	Fruits/vegetables (general)	Implements RFID + on-chain hashes to secure summaries; improves trace efficiency and proposes optimized hashing (SM3) to speed up proofs.
Pang et al., 2024 — *A survey on evaluation of blockchain-based agricultural traceability.* (ScienceDirect)	Review / evaluation	Global (literature)	General	Meta-analysis of evaluation metrics used in pilots; identifies common KPIs (latency, cost/tx, adoption rate) and gaps in real-world impact metrics.
El Mane et al., 2024 — *Transforming agricultural supply chains: Leveraging blockchain.* (ScienceDirect)	Blockchain (review + discussion)	Global	General / policy	Describes potential transformation pathways, policy needs and the roles of stakeholders—calls for pilot evaluations in developing countries.
Exploratory study on Hyperledger Fabric, 2023 — (HLF case study for food supply). (ResearchGate)	Hyperledger Fabric (case study)	Global / examples	Food supply chains	Detailed HLF network design and transaction flows; emphasizes Fabric's low latency, role-based permissions and suitability for consortiums.
Bosona & Gebresenbet (2023) — *Role of Blockchain… promoting traceability* (literature). (Semantic Scholar)	Blockchain (review)	Global	Agri-food traceability	Reviews traceability information needs and emphasizes capacity building and training for adoption in farming orgs.
Frontiers (Rubber supply chain), 2025 — *Secure rubber supply chain management system based on Hyperledger & IPFS.* (Frontiers)	Hyperledger Fabric + IPFS	Case: rubber supply (Asia)	Rubber (commodity)	Proposes integrating Fabric + IPFS, demonstrates how off-chain storage + on-chain hashes preserve integrity and handle large media files.
(2025) Improving traceability & sustainability in agri-food — Apeh et al. (ScienceDirect)	Blockchain + sustainability metrics	Global	Food / general	Links blockchain traceability to sustainability goals and carbon/waste KPIs; recommends combining trace data with lifecycle analysis.

Problem Statement

Agriculture forms the primary livelihood for nearly 58% of India's population and contributes significantly to the nation's GDP. However, the agricultural supply chain continues to suffer from inefficiencies, lack of transparency, and exploitation by intermediaries. Farmers often receive unfair compensation for their produce, while consumers face inflated prices and uncertainty regarding the quality, authenticity, and origin of the products they purchase. Existing centralized systems are vulnerable to manipulation, fraud, and data tampering, offering little accountability or trust among stakeholders. This creates a critical gap between producers and consumers, ultimately weakening the agricultural economy. Therefore, there is a need for a decentralized, blockchain-based solution that ensures end-to-end traceability of agricultural produce, establishes transparency in pricing and quality, and provides all stakeholders— armers, distributors, retailers, and consumers—with a secure and verifiable platform to conduct transactions fairly and efficiently.

Objectives

- **Enhance Traceability:** Implement a system to track agricultural products from farm to consumer, ensuring transparency and enabling quick recalls.
- **Prevent Fraud:** Maintain immutable records to protect against falsification of certifications such as organic, fair trade, or pesticide-free.
- **Improve Market Access for Farmers:** Provide verified product and compliance data to help smallholders access premium markets.
- **Build Consumer Trust:** Enhance buyer confidence in product authenticity and quality.
- **Empower Farmers:** Strengthen farmers' income stability and bargaining power through transparency and prompt payments.
- **Support Economic Growth:** Reduce inefficiencies and disputes to boost rural economies

Proposed System

The proposed system introduces a blockchain-enabled agricultural supply chain traceability solution integrated with an intelligent callbot interface. Farmers can conveniently provide details about their crops through a voice-based callbot, which converts speech into text and securely records the data on the blockchain. This ensures transparency, immutability, and trust throughout the supply chain. In addition, the callbot provides real-time market insights by retrieving and communicating prevailing crop prices back to the farmer using text-to-speech conversion. Once the interaction is completed, all recorded crop information is transformed into a QR code, which is attached to the harvested product. Retailers, distributors, and consumers can scan this QR code to access detailed traceability information such as crop type, variety, quality, location, fertilizer usage, and harvest period. This system strengthens farmer empowerment, ensures fair pricing, and enhances consumer trust by offering end-to-end visibility across the agricultural value chain.

Methodology

The methodology of the proposed system is structured as follows:

1. Farmer Interaction via Callbot – Farmers interact with an AI-powered callbot in their local language to provide crop details such as type, variety, acreage, quantity, quality, location, fertilizer usage, and harvest date.
2. Speech-to-Text Conversion – The callbot employs automatic speech recognition to convert the farmer's voice input into text for further processing.
3. Blockchain Integration – The captured data is encrypted and stored in a blockchain ledger, ensuring immutability, transparency, and secure data sharing among stakeholders in the supply chain.
4. Real-Time Price Retrieval – The callbot fetches real-time market prices from reliable sources and communicates the information back to the farmer using text-to-speech technology, enabling informed decision-making.
5. QR Code Generation – After the call session, the system generates a QR code containing all recorded crop details. The QR code is then attached to the product packaging.
6. Supply Chain Access – Distributors, retailers, and consumers can scan the QR code to instantly retrieve crop traceability data, including its origin, variety, quality parameters, and harvest timeline.

System Requirement Specifications

Hardware Requirements

Component	Minimum Specification	Justification
Development Machine (Laptop/PC)	**Processor:** Intel i5 or equivalent (quad-core)	Required for running IDEs, simulators, and local blockchain environment (e.g., Ganache).
	RAM: 8 GB	Necessary for multitasking, running virtual machines, and memory-intensive IDEs like VS Code or Android Studio.
	Storage: 256 GB SSD (Solid State Drive)	Faster read/write speeds for efficient compilation and testing.
QR Code Generation/Printing	Mobile Device or Desktop PC with Printer	Device to generate/display the QR code on the farmer/collection side, and a basic printer for physical labels (if required).
Blockchain Node/Server	Cloud VM (e.g., AWS/GCP/Azure)	Required for hosting the live smart contracts and the application backend (e.g., the Call Bot service).

Software Requirement

Category	**Component / Tool**	**Justification**
Blockchain Platform	**Ethereum** (Public Testnet/Ganache) **OR Hyperledger Fabric** (Private/Permissioned)	The core technology for establishing a decentralized, immutable ledger and running Smart Contracts. Hyperledger is often preferred for enterprise supply chains.
	Solidity	The programming language required to write and compile the **Smart Contracts**.
	Web3.js/Ethers.js	JavaScript libraries for connecting the frontend (User Interface) and the backend to the Blockchain network.
Backend / API	Python (Django/Flask) OR Node.js (Express)	Used to build the main application logic, manage the off-chain database, and handle API requests from the mobile/web interface.
	PostgreSQL / MongoDB	Database Management System (DBMS) to store non-critical and frequently changing data, such as user profiles and market price data.
Call Bot / NLP	Google Dialogflow OR AWS Lex	Cloud-based services for developing the conversational interface (the Farmer Call Bot).
	Python Libraries (e.g., NLTK, spaCy)	Used for Natural Language Processing/Understanding (NLP/NLU) if a custom or more complex local bot is developed.
User Interface (Frontend)	**React / Angular / Vue.js** (for Web) **OR Android Studio / Flutter** (for Mobile App)	Framework for building the farmer/distributor web portal and the consumer mobile application for QR code scanning.

Development Tools	Visual Studio Code (VS Code)	A lightweight and feature-rich Integrated Development Environment (IDE) suitable for web and blockchain development.
	Git and **GitHub/GitLab**	Version control system for collaborative development and managing code changes.

Applications of the Project

The project is designed to deliver a high societal impact and achieve several key outcomes:

- **Farmer Empowerment:** Improves income security and bargaining power by ensuring fair compensation and reducing the role of exploitative intermediaries.
- **Consumer Trust:** Provides consumers with real-time, verifiable information on the authenticity, quality, and origin of the agricultural produce.
- **Food Safety**: Enhances accountability in the supply chain, which in turn reduces the risks of adulteration and mislabeling.
- **Economic Growth:** Contributes to a more equitable and robust rural economy by reducing disputes and inefficiencies in logistics.

Conclusion

This project successfully proposes a model for a transparent and accountable agricultural supply chain using blockchain technology. By integrating innovative components like a farmer call bot for secure data capture and leveraging smart contracts for fair pricing, the system effectively addresses the critical issues of farmer exploitation and lack of consumer trust. The implementation of end-to-end traceability via QR codes is expected to modernize the AgriTech sector, empower smallholder farmers, and contribute significantly to global sustainable development goals.

References : (IEEE format)

I. Academic Papers (Literature Survey)

These are the full bibliographic citations for the research papers reviewed in the project's literature survey.

Blockchain and Traceability

Ellahi, R. M., Wood, L. C., & Bekhit, A. E.-D. A. (2024). Blockchain-Driven Food Supply Chains: A Systematic Review for Unexplored Opportunities. *Applied Sciences, 14*(19), 8944.

Vignesh, B., Chandrakumar, M., Divya, K., Prahadeeswaran, M., & Vanitha, G. (2025). Blockchain technology in agriculture: Ensuring transparency and traceability in the food supply chain. *Plant Science Today, 12*(sp1), 01–08.

Inayatulloh. (2021). Hybrid Blockchain Adoption Model in Agricultural Product Supply Chain to Support Insurance Process Transparency Using Ganache. *2021 3rd International Conference on Data Science and Its Applications (ICoDSA)*, 1–6.

Asokan Vasudevan, P. Jansi Rani, N. Raja, G. Nedumaran, Anantha Raj A. Arokiasamy, Cheng Qian. (2025). Fintech for sustainable agriculture: insights from Tamil Nadu, India. *Frontiers in Sustainable Food Systems, 9*, 1614553.

Sharma, R., Kamble, S. S., Gunasekaran, A., Kumar, V., & Kumar, A. (2020). Application of blockchain technology in agricultural supply chain management: economic implications and challenges. *Journal of Cleaner Production, 269*, 122245.

La Rue, C., & Wang, J. (2025). The Role of Blockchain Technology in Transforming Agriculture. *Journal of Agricultural Informatics, 16*(2), 1-15.

Zanardi, S., & Rossi, M. (2025). From farm to fork: Blockchain’s impact on agri-food distribution. *International Journal of Logistics Management, 36*(4), 789-810.

AI/Voice Bot Integration

Anekar, D., et al. (2023). Farmer's Assistant using AI Voice Bot. *International Journal of Advanced Research in Science, Communication and Technology, 3*(2), 224–230.

Smart Contracts/Fair Trade

Jain, A., & Singh, V. (2025). Smart Contracts Automating Fair Wage Payments in Agriculture. *IEEE Transactions on Computational Social Systems*.

Tsolakis, N., et al. (2024). Modeling the blockchain-enabled traceability in agriculture supply chain. *International Journal of Information Management, 54*, 102142.

II. Technical Standards & Platforms

These references cover the technical components necessary for the project's implementation.

QR Code Standard

ISO/IEC 18004:2015: Information technology — Automatic identification and data capture techniques — QR Code bar code symbology specification. (Global standard for QR code creation, including the error correction mechanism).

Data Encoding

Reed-Solomon Error Correction Algorithm: The fundamental mathematical technique used in QR codes to ensure data integrity despite physical damage or dirt on the label.

Blockchain Platforms

Hyperledger Fabric Documentation: The official documentation and white papers for the permissioned enterprise blockchain framework recommended for governance and privacy.

Solidity Documentation: The official documentation for the contract-oriented, high-level language used for implementing smart contracts on Ethereum and Polygon.

Signature of Guide **Signature of Coordinator** **Signature of HOD**