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Organic Food Traceability System using Blockchain Technology

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Abstract*: Traditional traceability system has problems of centralized management, opaque information, untrustworthy data, and easy generation of information islands. To solve the above problems, this paper designs a traceability system based on blockchain technology for storage and query of product information in supply chain of agricultural products. Leveraging the characteristics of decentralization, tamper-proof and traceability of blockchain technology, the transparency and credibility of traceability information increased. A dual storage structure of ''database + blockchain'' on-chain and off-chain traceability information is constructed to reduce load pressure of the chain and realize efficient information query. Blockchain technology combined with cryptography is proposed to realize the safe sharing of private information in the blockchain network. In addition, we design a reputation-based smart contract to incentivize network nodes to upload traceability data. Furthermore, we provide performance analysis and practical application, the results show that our system improves the query efficiency and the security of private information, guarantees theauthenticity and reliability of data in supply chain management, and meets actual application requirements.*

Keywords: Blockchain, traceability, organic food, agricultural products

I. INTRODUCTION

In light of the country's extensive agricultural terrain, favourable climate, and abundant biodiversity, veggies and fruit agricultural goods have notable production advantages in India. A significant amount of the country's agricultural production, or 306.82

million tons, was produced in 2019 as vegetable and fruit agricultural goods, according to information collected by the Indian Ministry of Agri and Farmers' Welfare. Agricultural products that grow fruits and vegetables are prized for their nutritional content, freshness, and ability to promote a healthy lifestyle. All around the nation, customers adore them. But because of their short shelf lives and unique storage needs which call for low temperatures to preserve quality and safety problems might arise. If these storage requirements are not met, food safety issues may occur, endangering consumers and affecting the supply chain whole.

To reduce these dangers and guarantee the agricultural sector's future prosperity in India, improvements in storage facilities and the application of efficient preservation methods are essential. India can further utilize its agricultural resources to ensure the availability of safe and nutritious produce for its population while enhancing its standing in the international market. This can be achieved by making investments in state-of-the-art storage facilities, implementing cutting-edge preservation techniques, and encouraging appropriate handling practices.

There is a growing realisation that investing in traceability infrastructure is essential not only for protecting public health but also for boosting consumer confidence, facilitating trade, and encouraging sustainable agricultural practises, as India continues to navigate the complexities of its agricultural sector. Thus, to promote a culture of accountability and traceability in India's agricultural industry, both public and private sector organizations are working together. S. L.

Bangare et al. [21-28], G. Awate et al. [29], N. Shelke et al. [30], P. S. Bangare et al. [31], S. Gupta et al. [32] and K. Gulati et al. [33] have shown significant research in AI and ML field.

This study's objectives are:

- A visible and unchangeable ledger of all supply chain transactions and operations is provided by blockchain technology. Customers may follow the path taken by their organic food products from the farm to their table, giving them peace of mind that the food they are buying is authentic and unadulterated.
- Organic certificates and labels can be authenticated using blockchain technology. This guarantees that organic products fulfil the necessary criteria and helps prevent bogus claims.
- Blockchain technology makes it possible to track the whole history of every organic food product, including details on the farm where it was grown, the techniques employed, and the environmental factors that affected it along the way. This improves the supply chain's confidence and accountability.
- There may be a serious problem with organic food fraud. Because every step in the supply chain is recorded and verifiable, blockchain helps lower the danger of false labelling or mixing non-organic items with organic ones. We discussed in detail the primary flaws in the agricultural product traceability system as it is today and offered some fixes.

II. LITERATURE SURVEY

Paper name	Year of publication	Methodology
1.Use a blockchain system to provide traceability in the European food supply chain.	2020	It's possible that the paper doesn't sufficiently address the scalability problems with blockchain technology. Managing a high number of transactions effectively can be very difficult in a real-world supply chain.
2.An overview of the user interface of blockchain based applications for agri-food traceability	2019	A lot of blockchain-based apps struggle to make their user interfaces intuitive. Because users, particularly those in the agri-food sector, may possess differing degrees of technical proficiency, it is imperative to provide an interface that is simple to use and comprehend.
3.A Reliable Blockchain-Based Fruit and Vegetable Agricultural Product Traceability System.	2021	Blockchain technology frequently comes into contact with intricate legal and regulatory systems. The suggested system's compliance with current legal requirements and any regulatory obstacles might not be covered in the paper.
4.Blockchain-based supply chain tracking for organic food. .	2021	Certain blockchain technologies are criticized for their effects on the environment, particularly those that employ proof-of-work consensus techniques. Research may look into more environmentally friendly options and address environmental concerns.
5. A secure information sharing protocol built on blockchain that is integrated with a key distribution mechanism in a supply chain management system.	2020	This research study addresses the issue of the necessity of a safe and effective information exchange protocol in supply chain management systems, especially in sectors where product traceability and sensitive data are vital.
6. A safety management system for the grain supply chain powered by blockchain.	2020	Making sure that farmers, distributors, and regulatory agencies all adopt and are compatible with a blockchain-based safety management system for the grain supply chain is a major obstacle to successfully tracking and tracing grain products throughout the

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		supply chain.
7. Product chain: A scalable blockchain architecture to facilitate supply chain provenance.	2018	In order to ensure food safety, quality control, and regulatory compliance, it can be very difficult to verify the authenticity and origin of products due to the lack of transparency and trust in traditional supply chains.
8. A hypothetical application: blockchain-based agriculture food supply chain management.	2023	This study paper's main focus is on the lack of trust and transparency in the agriculture food supply chain, which makes it challenging to trace the provenance, quality, and management of agricultural products.

III. DESIGN OF SYSTEM

System Framework

The links between agricultural product production, processing, logistics, and sales are the divisions of agricultural product traceability in this study. In addition to recording important data like seedling information, planting process information, environmental information, and product transaction information, the production link entails planting, transplanting, watering, fertilizing, and harvesting agricultural products that include fruits and vegetables. The processing link records the product information, processing procedure, processing environment, product transaction, and other important information. It also involves classifying, weighing, packing, pasting two-dimensional codes, and other operations for the selected fruits and vegetables. The term "transportation link" describes the movement of materials (like the Internet of Things) during the manufacturing, processing, shipping, and retail processes. Customers' faith in the safety of agricultural products can be increased by providing them with comprehensive information about the items through the use of a traceability system. Law enforcement organizations can identify the primary cause of quality and safety incidents involving agricultural products by tracking down the problematic link. The term "blockchain traceability" refers to the application of blockchain technology to agricultural product traceability systems. This type of traceability is accomplished by utilizing the decentralization, non-tampering, and traceability features of blockchain technology to guarantee the veracity and authenticity of traceability data and to produce efficient and dependable traceability.

The blockchain-based fruit and vegetable agricultural products traceability system uses the data storage scheme to manage the growth information, processing information, logistics information, and sales information of fruits and vegetables agricultural products. This allows it to monitor the entire process of agricultural product production, processing, transportation, and sales. The four main layers of the blockchain traceability system for agricultural products were storage, service, interface, and application.

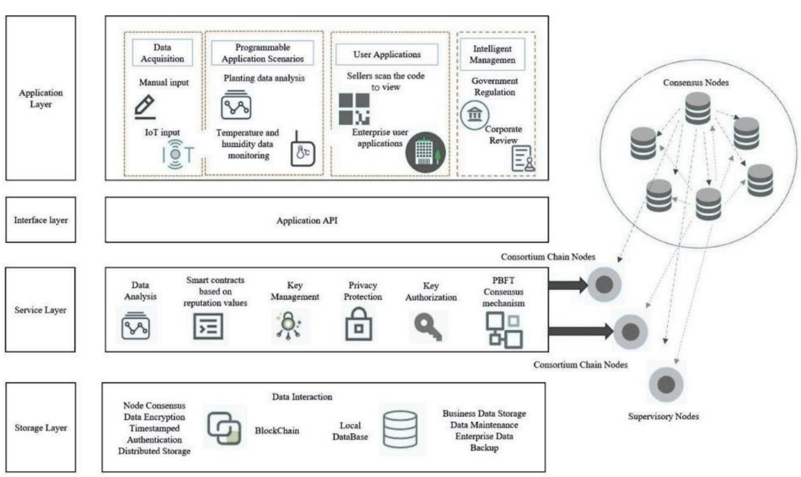

Fig 1. System Architecture

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These are some of the storage layer's databases: the system database, the local MySQL database, and the database that comes with the blockchain system. Every connection's public data is stored in the local database. The public information's hash value and the encrypted ciphertext of the private information are stored in the blockchain system

The required Key1 is randomly selected by the smart contract generate and upload encrypted ciphertext to the blockchain. In order to ensure the security of the Key1, this paper used the Elliptic Curves Cryptography (ECC) to encrypt the Key1. The encrypted Public Key authorized the viewing node. The Public Key of the authorized viewing node and the Encrypted Key1 form a key-value pair, stored in the world state of the smart contract and written to the blockchain. When the relevant enterprise nodes view the private data on the blockchain, the current node private key is used to decrypt the Encrypted Key1 on the blockchain to obtain the original Key1, and the Key1 is used to decrypt the private information and view the private information.

Information privacy protection procedure for traceability

Along with product traceability data, the complete supply chain also includes private data, including transaction information, that is only viewable by related organizations. Data privacy is a significant concern for rival businesses. In order to secure privacy and ensure traceability, this study designs a data flow where private information is encrypted using smart contracts and uploaded to the blockchain together with the hash value of public information. Figure 2 illustrates how the AES encryption algorithms Cipher Block Chaining (CBC) mode encrypts sensitive data, including transactional data.

The smart contract generates and uploads encrypted ciphertext to the blockchain, selecting the necessary Key1 at random. This work encrypted the Key1 using Elliptic Curves Cryptography (ECC) to guarantee its security. The viewing node was approved by the encrypted Public Key. A key-value pair is created by the authorized viewing node's public key and the encrypted key1, which is uploaded to the blockchain and kept in the smart contract's world state. The private key of the current node is used to decrypt the blockchain's encrypted Key1 in order to recover the original Key1, and the Key1 is then used to decrypt the private information and view the private information when the appropriate enterprise nodes examine the private data on the blockchain.

Infrared Flame Sensor

Flame sensors have a wavelength range of 760 to 1100 nm, which allows them to detect both light and fire sources. They work well in a variety of environmental settings, such as those with ice, water vapor, oil, and dust. Because it uses flame detecting techniques, its response is often better than that of heat or smoke sensors. With the use of UV (Ultraviolet), IR (Infra-Red), or UV-IR technologies, flame sensors can identify flames quickly and precisely—sometimes in less than a second. A flame sensor's output can be either digital or analog, which gives it versatility for uses like file integration or flame alarms

IV. SOFTWARE REQUIREMENTS

For Software Interfaces:

- Operating System: Windows 10(64 Bit)
- IDE: Eclipse IDE
- Programming Language: Java

V. SYSTEM IMPLEMENTATION

Stakeholder identification: List the important players in the organic food supply chain, including farmers, distributors, suppliers, retailers, and certifying organizations.

Defining the data to be recorded: Ascertain the precise data, such as product specifications, origin, certifications, farming methods, and any third-party audits, that must be tracked and recorded on the blockchain.

Selecting a blockchain system: Choose a blockchain platform such as Ethereum, Hyperledger Fabric, or Corda that meets the needs of the project.

Creating smart contracts: Make smart contracts that automate tasks like product monitoring, auditing, and certification verification while also enforcing adherence to organic certification criteria.

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Creating a decentralized network: To guarantee the blockchain's immutability and transparency, create a decentralized network of nodes. This may entail using already-existing blockchain networks or working with stakeholders to host nodes.

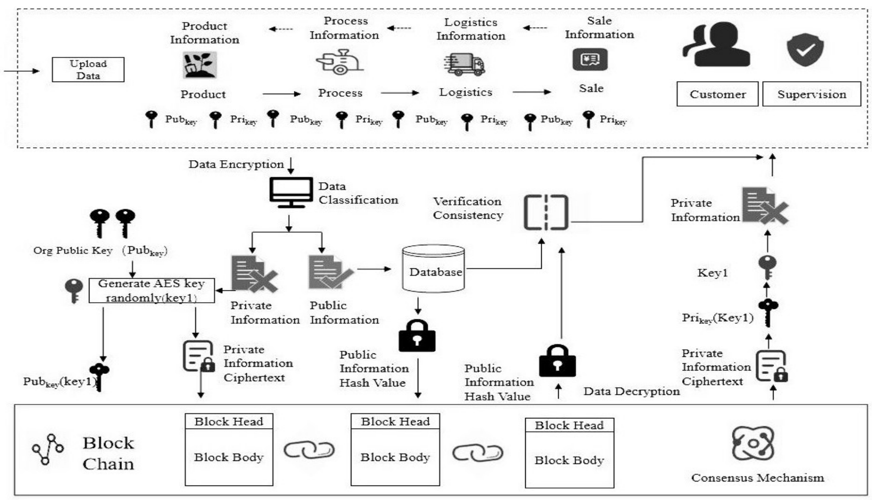

Fig 2. Traceability information privacy protection data flow diagram

Integrating with current systems: To guarantee smooth data flow and interoperability, integrate the blockchain solution with current systems and databases that are utilized by stakeholders.

Data input and validation: Verify information against defined criteria and carry out recurring audits to guarantee correct and trustworthy data entry into the blockchain.

Piloting and testing: To confirm the efficacy and efficiency of the blockchain solution in practical situations, carry out pilot projects and testing stages.

Adoption and scaling: After the solution has been successfully tested, expand stakeholder participation and adoption by implementing it more widely throughout the organic food supply chain.

ALORITHMS

Algorithm 1: Peer to Peer Verification Protocol
Input: User obtains Transaction TID, IP address,
Output: If there is a valid connection, enable the IP address or the current query.
Step 1: The user creates a DDL, DML, or DCL query for any transaction.
Step 2: Obtain your IP address right now
If (connection (IP) equals(true))
Flag true
Else
Flag false
End for
Step 4: if (Flag == true) Peer to Peer Verification valid
Else
Peer to Peer Verification Invalid
End if
End for

Algorithm 2: Generation of Hash Values
Input: data d, the Genesis block, the previous hash,
Hash H was generated based on the provided data.

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Step 1: Input data as d
Step 2: Apply SHA 256 from SHA family
Step 3: Current Hash= SHA256(d)
Step 4: Return Current Hash

Algorithm 3: Mining Algorithm for the development of valid hashes
Current hash values, hash Val;
Input: Hash Validation Policy P [];
Output: Valid hash
Step 1: System generate the hash Val for i th transaction using Algorithm 1
Step 2: if (hash Val. valid with P [])
Flag =1
Else
Flag=0
Step 3: Return valid hash when flag=1

Algorithm 4: Recover Block Chain Data
Input: User Transaction inquiry, Old NodesChain [Nodeid], Current Node Chain CNode[chain]
Return if any chain is invalid; otherwise, carry out the current query
Step 1: User generate the any transaction DDL, DML or DCL query
Step 2: Get current server blockchain Cchain ← Cnode [Chain]
Step 3: Foreach (read I into NodeChain) If (! equals NodeChain[i] with
(Cchain))
Flag 1
Else Continue Commit query
Step 5: if (Flag == 1)
Count = Similarly NodesBlockchian ()
Step6: Calculate the majority of server
Recover invalid blockchain from specific node
Step7: Endif

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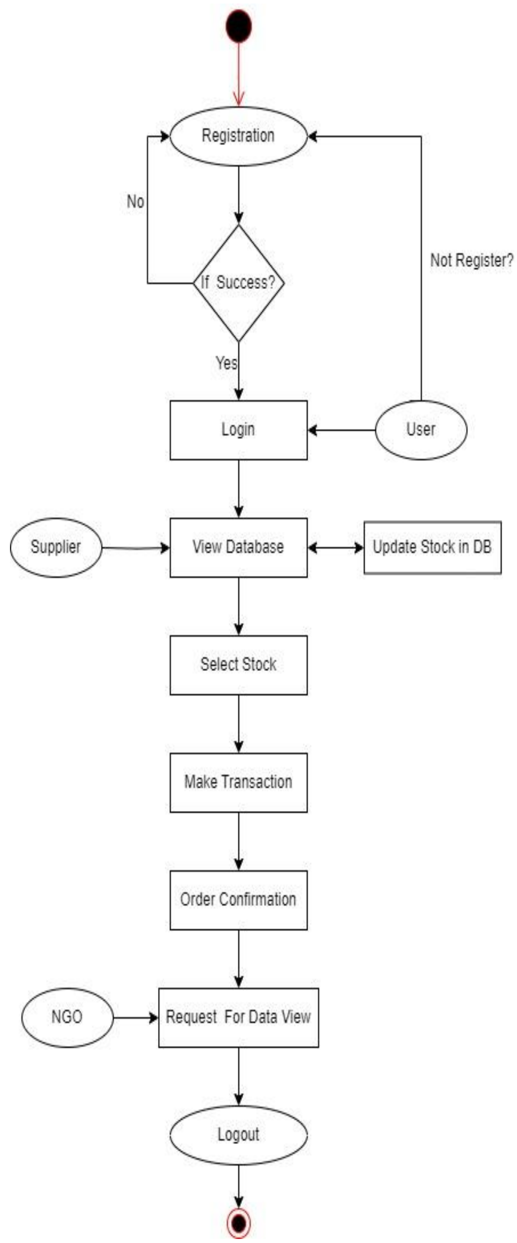
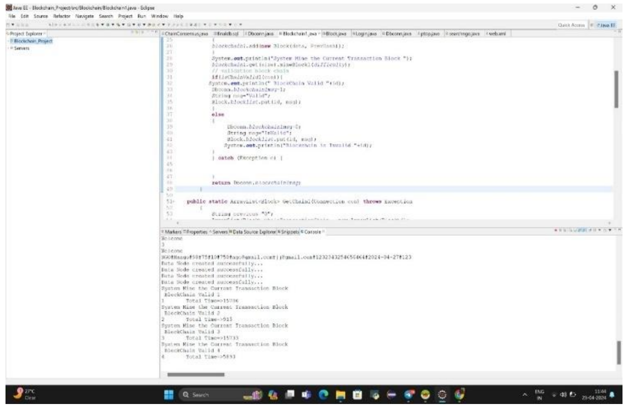
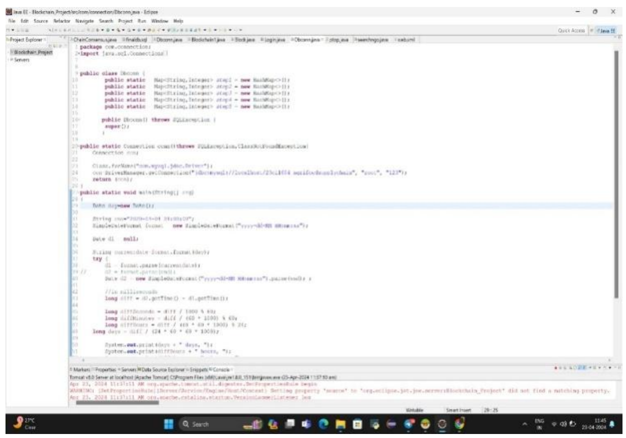
RESULTS:

1. Activity Diagram
2. Peer To Peer Verification:
3. Hash Generation:
4. Mining Algorithm for Valid Hash Creation:





Recover Blockchain Data:



VI. FUTURE SCOPE

Organic Food Traceability using Blockchain" makes use of blockchain technology to improve supply chain transparency for organic food. It uses smart contracts to automate certification procedures, guarantees the veracity of organic claims, and gives customers the power to make wise decisions. The organic food business may see future growth and sustainability through broader acceptance, IoT integration, AI-enhanced data analytics, international expansion, and sustainability tracking.

VII. CONCLUSION

Upon In this work, we addressed the storage and query design of the system and created and implemented the fruit and vegetable agricultural product traceability system based on the non-tampering and traceable features of blockchain. A method for storing data both on and off-chain using "database blockchain" is suggested in order to address the issues of high data load pressure and inadequate private security of the blockchain traceability system as the amount of data increases. The supply chain stores the public data that is shown to customers in a local database, whose hash value is uploaded to the blockchain system using the SHA256 method. The blockchain stores the private data that has been encrypted using the CBC encryption technique so that it can be shared with relevant businesses. The storage strategy suggested in this study reduces the pressure of data load on the chain by combining the real scenario, accounting for the requirement for public oversight of supply chain public information and the necessity for encryption of business private information. The connection between the blockchain and the database is established by keeping the public information's block number on file.

The system checks the information based on the relevant block number recorded in the database to ascertain whether the product information has been tampered with. The consumer accesses the application to acquire public information from the database. Multi-chain is the route of development that blockchain technology will go in the future to fulfil real business needs. We plan to investigate cross-chain technologies in more detail in the future, as well as a novel consensus mechanism that is appropriate for traceability.

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