AGRICULTURAL DATA MARKETPLACE

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING

Use Case Report
submitted by

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CERTIFICATE

This is to certify that the Use Case report entitled **"Agricultural Data Marketplace"** that is being submitted by **Mogal Safiya(22501A05B1)**, as part of Assignment-1 and Assignment-2 for the **Blockchain Technology**(**20CS4601C)** course in **3-2** during the academic year **2024-25**.

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1. INTRODUCTION

1.1. Overview of Blockchain Technology

Blockchain is a technology that can bring breakthroughs in the agriculture sector with its potential. By allowing information to be traced across the agricultural supply chain, blockchain agriculture enhances food safety. The ability of blockchain to store and manage data allows for traceability, which is used to aid in the development and implementation of intelligent farming and index-based crop insurance systems.

Blockchain technologies can track all types of information about plants, such as seed quality, and crop growth, and even generate a record of the journey of the plant after it leaves the farm. This data can improve supply chain transparency and eliminate concerns associated with illegal and unethical operations. In the case of a recall, they can also make it easier to track any contamination or other issues back to their source. The primary goals of these technologies are sustainability and food security. When consumers have this amount of transparency, they can make informed purchasing decisions. They frequently utilize this information to reward farmers and producers that implement good farming methods.
Blockchain is the only way that traceability can be brought reliably to farm produce with the distributed market architecture.

IoT devices and sensors are being introduced by agritech companies, and blockchain technology can be used to consolidate data on a variety of topics, including seed quality, crop tracking, and the path of crops from the farm to the market.
Apart from increasing transparency in the food supply chain, blockchain technology can also improve security.

1.2. Relevance of Blockchain in Agricultural Data Marketplace

In the agricultural supply chain, there are often numerous intermediaries between farmers or producers and consumers. As a result, consumer demands such as purity, quality, quantity, and the absence of adulteration are frequently unmet. Similarly, farmers' expectations, including fair prices, timely payments, reduced involvement of middlemen, and lower transportation costs, are not always satisfied. This lack of alignment between consumer and farmer needs highlights inefficiencies in the system that can negatively impact both parties.

To avoid such problems, one useful technology is blockchain. Blockchain technology holds significant potential to address many challenges in the agricultural marketplace, especially concerning the transparency, fairness, and efficiency of the supply chain. In the traditional agricultural supply chain, numerous intermediaries often complicate the process, leading to inefficiencies and increased costs for both farmers and consumers.

Blockchain, with its decentralized, secure, and immutable ledger system, can provide a direct, transparent path from farmers to consumers, ensuring that both parties' demands are met more effectively.
Blockchain provides traceability with each transaction recorded on an immutable digital ledger, consumers can track journey of their food from farm to table. By this the consumer can ensure the quality, quantity, and purity of their food for reasonable prices. They can also know how the crop is cultivated and verifying that organic produce has been grown without synthetic chemicals.

By enabling direct transactions between farmers and consumers or retailers, blockchain ensures that farmers receive a fairer price for their produce without being exploited by intermediaries. This streamlined approach not only increases the profit margin for farmers but also reduces the overall cost for consumers, creating a more efficient and equitable market.

Finally, blockchain can significantly improve the efficiency of the agricultural supply chain. Real-time data and insights into inventory management, logistics, and transportation can be made available to all parties involved, reducing delays, spoilage, and wastage. By providing a transparent and efficient process, blockchain helps ensure that products reach the market in optimal condition, while also reducing costs related to transportation and middlemen. The reduction in transaction costs not only benefits farmers by improving their profit margins but also results in more affordable prices for consumers.

In addition to addressing transparency and efficiency in the agricultural supply chain, blockchain technology can also provide valuable opportunities for researchers and students. By securely storing and sharing agricultural data on the blockchain, researchers can access accurate, real-time information on crop yields, soil health, weather patterns, and farming practices. This data can be used to conduct studies, develop new farming techniques, and improve sustainability practices. Furthermore, students and academic institutions can benefit from the availability of this data for educational purposes, allowing them to gain deeper insights into agricultural systems, participate in hands-on learning experiences, and contribute to innovative solutions for global food security challenges. By making data accessible and transparent, blockchain fosters collaboration and knowledge-sharing among researchers, students, and industry professionals, driving advancements in agriculture.

2. BACKGROUND

The agricultural marketplace faces a variety of challenges that hinder its efficiency, sustainability, and growth. These challenges affect both producers and consumers, and addressing them is crucial for improving the overall functioning of the agricultural sector. Now, Let's see some major challenges in Agricultural sector:

2.1. Lack of output quality

Now days where we are getting the agriculture produces are low because there are some factors which influence the quality of output agriculture produce. There is low quality of seeds, old methods of cultivation; lack of pest and disease control measures, the big factor is climatic factors (like droughts or floods) and deliberate adulteration and dumping and so on.

2.2. Lack or improper way of information

Due to lack of information, the farmers do not usually get adequate about the price that prevails in big and organized markets. The information about market prices do not reach the farmers because the lack of communication facilities. The other factors are farmers take at face value whatever price rules in all parts of the market.

2.3. Lack of grading

Indian farmers do not give importance to grading of their produce. They hesitate to separate the qualitatively good crops from bad crops. Therefore, they fail to fetch a good price of their quality product.

2.4. Insufficient Storage

There is no proper storage or warehousing facilities for farmers in the villages where they can store their agricultural produce. Every year 15 to 30% of the agricultural produce are damaged either by rats or rains due to the absence of proper storage facilities. Thus, the farmers are forced to sell their surplus produce just after harvests at a very low and unremunerative price.

2.5. Unfavorable Markets

The condition of the markets are also not at all favorable to the farmers. In the markets, the farmers will have to wait for disposing their produce for which there is no storage facilities.

2.6. Adulteration and Quality Control

Ensuring the quality and purity of agricultural products is a significant challenge. Adulteration and contamination of food products, whether intentional or accidental, undermine consumer trust and pose serious health risks. The lack of robust quality control systems throughout the supply chain often leads to food fraud, where products are misrepresented or diluted with lower-quality ingredients.

2.7. Climate Change and Environmental Factors

Agriculture is highly vulnerable to climate change, which affects crop yields, water availability, and overall farming conditions. Extreme weather events like droughts, floods, and heatwaves can destroy crops and disrupt farming activities. Additionally, changing climate patterns can lead to pest outbreaks, soil degradation, and loss of biodiversity.

2.8. Access to Finance

Smallholders, struggle to access credit and financing to fund their operations. The lack of access to affordable loans and financial support can prevent farmers from investing in necessary tools, technology, or infrastructure improvements.

2.9. Lack of Data and Technological Adoption

In many regions, farmers have limited access to data on market trends, weather patterns, and agricultural best practices. This lack of information can make it difficult for them to make informed decisions about planting, harvesting, and marketing their products.

2.10. Consumer Demands for Sustainability

As consumers become more conscious of the environmental and social impacts of their food choices, they are demanding more sustainable and ethically produced agricultural products. Farmers face pressure to adopt more environmentally friendly practices, such as reducing pesticide use, conserving water, and maintaining soil health.

3.BLOCKCHAIN BASICS

In 2008, a groundbreaking paper entitled Bitcoin: A Peer-to-Peer Electronic Cash System was written on the topic of peer-to-peer electronic cash under the pseudonym Satoshi Nakamoto. It introduced the term chain of blocks.

Blockchain is a peer-to-peer, distributed ledger that is cryptographically-secure, append-only, immutable (extremely hard to change), and updateable only via consensus or agreement among peers.

Key concepts of Blockchain:

3.1. Decentralization

There is no need for a trusted third party or intermediary to validate transactions; instead, a consensus mechanism is used to agree on the validity of transactions.

3.2. Immutability

Once the data has been written to the blockchain, it is extremely difficult to change it back. It is not genuinely immutable, but because changing data is so challenging and nearly impossible, this is seen as a benefit to maintaining an immutable ledger of transactions.

3.3. Transparency and trust

Blockchains are shared and everyone can see what is on the blockchain, this allows the system to be transparent. As a result, trust is established. This is more relevant in scenarios such as the disbursement of funds or benefits where personal discretion in relation to selecting beneficiaries needs to be restricted.

3.4. High availability

As the system is based on thousands of nodes in a peer-to-peer network, and the data is replicated and updated on every node, the system becomes highly available. Even if some nodes leave the network or become inaccessible, the network as a whole continues to work, thus making it highly available. This redundancy results in high availability.

3.5. Highly secure

All transactions on a blockchain are cryptographically secured and thus provide network integrity.

3.6. Faster dealings

In the financial industry, especially in post-trade settlement functions, blockchain can play a vital role by enabling the quick settlement of trades. Blockchain does not require a lengthy process of verification, reconciliation, and clearance because a single version of agreed-upon data is already available on a shared ledger between financial organizations.

3.7. Smart Contracts

Blockchain technology provides a platform for running smart contracts. These are automated, autonomous programs that reside on the blockchain network and encapsulate the business logic and code needed to execute a required function when certain conditions are met.

3.8. Updateable via consensus

The most critical attribute of a blockchain is that it is updateable only via consensus. This is what gives it the power of decentralization. In this scenario, no central authority is in control of updating the ledger. Instead, any update made to the blockchain is validated against strict criteria defined by the blockchain protocol and added to the blockchain only after a consensus has been reached among all participating peers/nodes on the network. To achieve consensus, there are various consensus facilitation algorithms which ensure that all parties are in agreement about the final state of the data on the blockchain network and resolutely agree upon it to be true. Consensus algorithms are discussed later in this chapter and throughout the book as appropriate.

4. USE CASE OVERVIEW

A blockchain-based agricultural marketplace is a decentralized platform that leverages blockchain technology to facilitate transparent, secure, and efficient trade between farmers, buyers, and other stakeholders in the agricultural supply chain.

4.1. Objectives

The primary objective is that it ensures transparency and traceability throughout the supply chain. By recording every transaction on an immutable ledger, blockchain allows participants to track the origin and movement of agricultural products, reducing fraud, counterfeiting, and food contamination. This fosters greater trust between consumers and producers, ensuring that products meet quality and safety standards.

It provides fair pricing and financial inclusion for farmers, especially smallholders who often face exploitation by middlemen. By enabling direct farmer-to-consumer (F2C) trade, blockchain eliminates intermediaries and allows for real-time price discovery based on actual supply and demand. Additionally, integrating blockchain-based payments, including cryptocurrencies and stablecoins, ensures faster transactions and financial access for unbanked farmers, reducing dependency on traditional financial institutions.

Smart contracts play a crucial role in automating transactions, ensuring that payments are released automatically upon delivery of goods. These self-executing contracts minimize paperwork, lower transaction costs, and reduce disputes between buyers and sellers. Furthermore, blockchain enhances supply chain efficiency by enabling real-time monitoring of logistics and storage conditions. This reduces food wastage, prevents delays, and improves quality control, ensuring that perishable goods reach consumers in optimal condition.

Sustainability and ethical farming are also key objectives of a blockchain-based agricultural marketplace. Blockchain can securely store certifications for organic, fair-trade, and sustainable farming practices, allowing consumers to verify the authenticity of these claims. Additionally, it can be used to track environmental factors such as carbon footprints and water usage, incentivizing eco-friendly agricultural practices.

Beyond improving trade, blockchain technology facilitates access to agricultural credit and insurance. By using blockchain-based credit scoring, farmers can obtain loans without relying on traditional banks. Similarly, smart contracts can automate crop insurance payouts based on real-time weather data and yield assessments, ensuring farmers receive timely compensation in case of natural disasters or crop failures.

4.2. Scope

The scope of Agricultural data marketplace extends across various areas of agriculture, trade, financial services, research, and development

1. **Supply Chain Transparency and Traceability:** Blockchain enables farmers, distributors, and consumers to track the movement of agricultural products from farm to table.

2. **Direct Farmer-to-Consumer (F2C) Trade:** Through decentralized marketplaces, farmers can list their products, and buyers can place orders with transparent pricing mechanisms.

3. **Smart Contracts for Automated Transactions**: Smart contracts can be used to automate transactions, reducing delays and ensuring seamless payments.

4. **Financial Inclusion and Digital Payments:** Blockchain can enable secure and fast digital payments through cryptocurrencies or stablecoins, reducing dependence on traditional banking systems.

5. **Sustainable and Ethical Farming Practices:** Blockchain enables the verification of organic, fair-trade, and sustainable farming practices.

6. **Improved Logistics and Storage Management:** By integrating blockchain with Internet of Things (IoT) devices, stakeholders can monitor real-time data on temperature, humidity, and other factors affecting food quality.

7. **Research and Development in Agriculture:** Researchers and agricultural scientists can leverage blockchain to collect and share data related to soil health, crop yields, and climate patterns. This data can be used to improve farming techniques, develop better agricultural policies, and enhance food security at a global level.

4.3. Architecture

The architecture of the Blockchain-Based Agricultural Data Marketplace consists of the following components:

4.3.1. Physical Layer

The physical or infrastructure layer assists in gathering environmental data, such as soil pH, temperature, humidity, and light exposure measurements. We also have nodes, which are network members. A node is any device that has permission to access blockchain network.

4.3.2. Blockchain Network

Blockchain, as a concept, organizes data into user data, agricultural product data, and transaction data. Blockchains employ consensus methods to make sure the nodes reach an agreement. It is a fantastic procedure to increase the network's efficiency by introducing a new degree of dependability and achieving information security.

4.3.3. Smart Contracts

Large portions of the model are at the level of smart contracts. The middleman got just eliminated. You will not have to worry about trust issues since there are standards protecting everyone's legal rights. Since everything gets computerized, higher authorities cannot have any impact, and the procedure is quite open.

4.3.4. App platform

The Kaleido interface serves as a functional testing platform. It assists in facilitating access to the decentralized ledger. The users receive great help from this layer. This platform enables access to all data. Peer-to-peer server networks allow users to connect to the blockchain network.

The front end of choice for most online apps stays the same. The research will use a cutting-edge web application built on the foundations of HTML, CSS, JavaScript, and TypeScript to deliver additional functionalities.

Programming languages handle the crucial business logic required by the applications. It is necessary to utilize the Solidity programming language and create source code that will automate various functions, such as identifying the circumstances of crop growth. However, no technology can provide complete 100% security. The blockchain network consistently adheres to best practices to guarantee the highest data and transaction protection level and reduce risks.

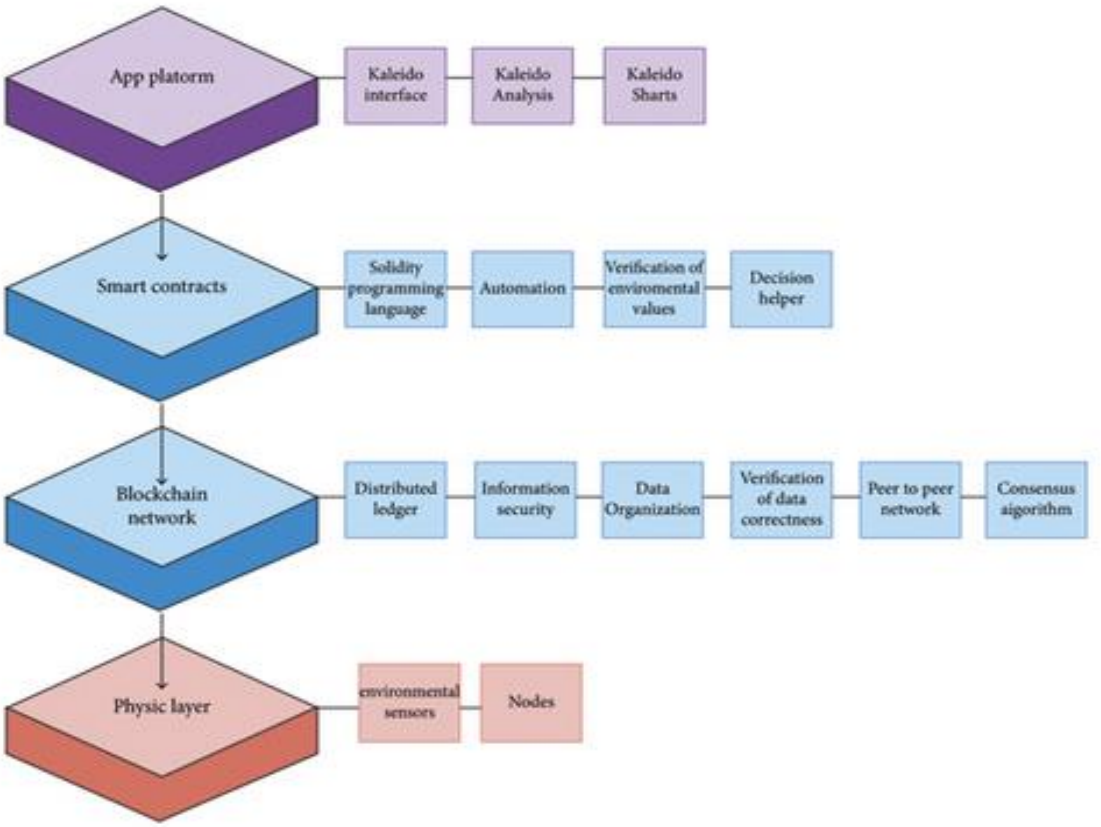

Fig.:1 Shows technology stack used

Note: The image is from research article: Agriculture Supply Chain Management Based on Blockchain Architecture and Smart Contracts (Academic Editor**:** Imran Ashraf, First published: 21 October 2022)

In additional to this application, we can also use IOT for more features. If added the Internet of Things (IoT) layer is the first. It consists of essential sensors like humidity, temperature, pressure, acceleration, and other variables connected to ARDUINO boards. Bluetooth or a wireless network is used to communicate between the devices. The Arduino features will provide us with data, which will be exploited in the subsequent layers.
Fig. 2 shows its functionality.

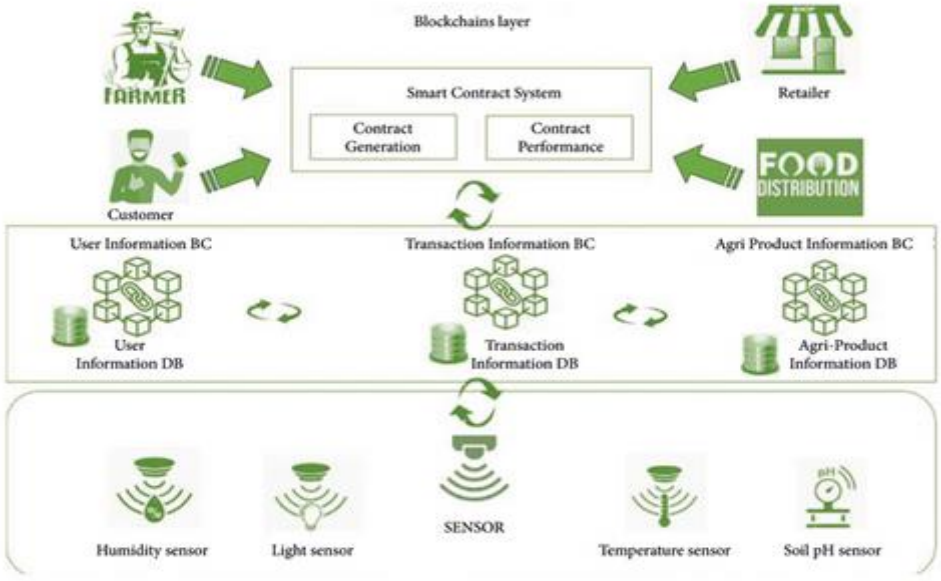

Fig.:2

Note: The image is from research article: Agriculture Supply Chain Management Based on Blockchain Architecture and Smart Contracts (Academic Editor**:** Imran Ashraf, First published: 21 October 2022)

5.IMPLEMENTATION

5.1. Define Stakeholders

- **Farmers:** Input data about crops, harvests, and storage conditions.
- **Distributors:** Track shipments and ensure timely delivery.
- **Retailers:** Verify product quality and authenticity.
- **Consumers:** Access product information and traceability data.
- **Regulators:** Monitor compliance with food safety standards.

5.2. IoT Integration & Data Collection

- IoT devices will be deployed to collect real-time data on:
  Environmental Conditions: Temperature, humidity, and soil quality.
  Location Tracking: GPS data for shipment tracking.
  Quality Metrics: Data on product freshness and storage conditions.
- Ensure compatibility and data accuracy across devices.

5.3. Select Blockchain platform

- Choose the appropriate blockchain platform (Ethereum, BSC, Tendermint, Hyperledger Fabric, Cosmos, etc.).
- Develop a token system for payments and incentives with secure token integration.
- Smart contracts will automate key processes, including:
  Product Tracking: Recording the movement of goods across the supply chain.
  Payments: Facilitating transactions between stakeholders.
  Quality Assurance: Enforcing compliance with quality standards.

5.4. Smart Contracts & Identity Management

- Develop and test smart contracts for tracking, payments, and incentives.
- Implement an identity management system using cryptographic keys for secure access.

Below is sample solidity code which shows assets data collection which helps formers to sell their properties and buyers to purchase the properties.
All this process will be done very securely because the data is available at each node. So, we can avoid illegal occupations of land.
There will be only one legal owner for the property.

Example code:

```
pragma solidity ^0.8.20;

contract AgriDataMarketplace {
    struct DataAsset {
        uint id;
        string description;
        uint price;
        address owner;
        bool available;
    }

    mapping(uint => DataAsset) public dataAssets;
    uint public assetCounter;
    mapping(address => uint) public balances;

    event DataListed(uint id, string description, uint price, address owner);
    event DataPurchased(uint id, address buyer);

    function listData(string memory _description, uint _price) public {
        assetCounter++;
        dataAssets[assetCounter] = DataAsset(assetCounter, _description, _price,
msg.sender, true);
        emit DataListed(assetCounter, _description, _price, msg.sender);
    }

    function purchaseData(uint _id) public payable {
        require(dataAssets[_id].available, "Data not available");
        require(msg.value >= dataAssets[_id].price, "Insufficient payment");

        address seller = dataAssets[_id].owner;
        payable(seller).transfer(msg.value);
        dataAssets[_id].available = false;

        emit DataPurchased(_id, msg.sender);
    }
}
```

This contract allows farmers to list data and buyers to purchase it securely.

5.5. User Experience & Interface Design

- Create a user-friendly dashboard for farmers and consumers.
- Ensure mobile and web accessibility.

5.6. Regulatory Compliance & Governance

- Ensure compliance with food safety regulations.
- Establish governance frameworks for decision-making and dispute resolution.

5.7. System Deployment & Maintenance

- Conduct rigorous testing via pilot programs.
- Provide training and deploy the system with continuous monitoring and support.

5.8. Data Analytics & Reporting

- Implement analytics tools to monitor supply chain performance.
- Generate insights and reports for stakeholders.

6. BENEFITS

A blockchain-based agriculture marketplace offers enhanced transparency, traceability, and efficiency, leading to improved food safety, reduced fraud, and fairer payments for farmers, ultimately benefiting both producers and consumers.

6.1. Increased Transparency and Traceability

Blockchain allows for a clear and immutable record of the entire agricultural supply chain, from farm to consumer, building trust and confidence.

6.2. Fairer Payments and Reduced Transaction Costs

Smart contracts can automate payments, ensuring farmers receive timely and accurate compensation, eliminating the need for intermediaries and reducing transaction fees.

6.3. Access to Wider Markets

Blockchain platforms can connect farmers with a broader network of buyers, expanding their market reach and potentially increasing prices.

6.4. Improved Quality Control and Food Safety

Blockchain enables real-time tracking of agricultural products, facilitating better quality control and ensuring food safety standards are met.

6.5. Better Access to Information

Consumers can access detailed information about the agricultural products they are purchasing, including farming practices, certifications, and sustainability efforts.

6.6. Sustainable Practices

Blockchain can help track and verify sustainable farming practices, allowing consumers to support producers who prioritize environmental responsibility.

6.7. Reduced Fraud & Counterfeiting

Blockchain records real-time farm data, ensuring only verified products enter the market. Once data is recorded on blockchain, it cannot be altered, preventing manipulation.

6.8. Data Monetization for Farmers

IoT-based soil and crop data can be sold to researchers, agritech firms, and policymakers. Buyers can use blockchain data for predictive farming models to optimize yields.

7. CHALLENGES

While blockchain technology offers significant benefits for agriculture, still we several challenges and limitations.
Some of them are listed below:

7.1. High Initial Implementation Cost

Setting up a blockchain-based marketplace requires investment in hardware, software, and training. Requires specialized blockchain developers, making it costly for small-scale farmers.

7.2. Digital Divide & Low Technical Knowledge

Many rural farmers have limited or no internet access, making blockchain adoption difficult. Smallholder farmers may not be familiar with crypto wallets, smart contracts, or blockchain transactions.

7.3. Scalability Issues

Public blockchains like Ethereum have high gas fees, making transactions expensive. Blockchain networks can become slow when handling large numbers of transactions.

7.4. Resistance from Middlemen & Traditional Market Players

Middlemen, distributors, and brokers may oppose blockchain adoption as it reduces their role.

7.5. Data Privacy & Security Concerns

Storing agricultural data (e.g., farm productivity, soil quality) on a public blockchain may lead to privacy risks. Poorly written contracts can be exploited by hackers, leading to financial losses.

7.6. Integration with IoT & Legacy Systems

Different farms use different IoT sensors, making data integration difficult. IoT devices in rural areas may have limited network coverage, affecting real-time blockchain updates.

7.7. Regulatory & Legal Uncertainty

Many countries lack clear laws for blockchain-based transactions in agriculture. Crypto payments for farm produce may face legal and tax-related issues.

7.8. Adoption of Crypto & Payment Issues

Farmers may be hesitant to accept payments in crypto due to price fluctuations. Farmers in developing countries lack access to crypto exchanges for converting funds.

8. CONCLUSION

A blockchain-based agricultural data marketplace has the potential to revolutionize the farming sector by ensuring transparency, security, and fair compensation for data providers. By leveraging decentralized networks, smart contracts, and IPFS storage, farmers can monetize their agricultural data, researchers can access reliable datasets, and agribusinesses can make data-driven decisions with trust and accuracy.

While blockchain technology in agriculture is still evolving, its potential to revolutionize data management, enhance trust, and improve the overall efficiency of the agricultural ecosystem is undeniable. With continued advancements in blockchain infrastructure, regulatory frameworks, and digital inclusion efforts, the widespread adoption of a blockchain-based agricultural data marketplace can significantly contribute to a more sustainable and technologically advanced farming industry.

8.1. Future Outlook for Enhancements

Several enhancements can further improve the effectiveness and adoption of blockchain-based agricultural data marketplaces:

- **Integration with AI & Machine Learning**: By incorporating AI-driven analytics, predictive modelling can optimize farming techniques, pest control, and resource allocation based on blockchain-verified data.
- **Interoperability with Existing Agricultural Systems:** Ensuring seamless integration with IoT devices, cloud storage, and traditional farm management software will improve usability and data accuracy.
- **Scalability Improvements:** The adoption of Layer-2 scaling solutions, such as sidechains or rollups, can reduce transaction fees and improve network performance.
- **Government and Institutional Support:** Policymaker engagement and the development of regulatory frameworks can encourage wider adoption and standardization in the agricultural sector.
- **Enhanced Data Privacy Mechanisms:** Implementing Zero-Knowledge Proofs (ZKPs) and confidential smart contracts can enhance privacy while maintaining data integrity.
- **Tokenized Incentives for Participation:** The use of blockchain-based incentive mechanisms, such as token rewards for data contributions, can increase participation and engagement in the marketplace.

9. SDG'S ADDRESSED

A Blockchain-Based Agricultural Data Marketplace aligns with several United Nations Sustainable Development Goals (SDGs) by promoting transparency, efficiency, and sustainability in agriculture. Below are the key SDGs covered:

SDG 1: No Poverty

Blockchain provides financial inclusion by enabling small-scale farmers to access markets without intermediaries. Facilitates micro-financing and DeFi loans, allowing farmers to obtain credit with tokenized assets or smart contracts. Ensures fair compensation for farmers by reducing exploitation in agricultural supply chains.

SDG 2: Zero Hunger

Blockchain technology improves food security through real-time tracking of crops, yields, and distribution. Reduces food wastage with transparent supply chain management. Encourages sustainable farming by providing trusted data on soil health, weather patterns, and crop performance.

SDG 8: Decent Work and Economic Growth

Blockchain creates new economic opportunities for farmers, traders, and agritech startups by fostering a decentralized marketplace. Smart contracts eliminate exploitative intermediaries, ensuring fair wages for agricultural workers. The marketplace also encourages innovative agricultural financing models, such as crop insurance based on real-time blockchain data, ensuring that farmers are not left vulnerable to unexpected financial losses.

SDG 9: Industry, Innovation, and Infrastructure

The use of blockchain in agriculture promotes digital transformation, allowing for the development of agritech solutions, automated supply chains, and secure data-sharing platforms. By integrating IoT, AI, and blockchain, precision farming is improved, leading to sustainable agricultural production. The infrastructure provided by blockchain reduces inefficiencies, enhancing productivity and innovation in agribusiness.

SDG 12: Responsible Consumption and Production

Blockchain enables traceability of agricultural products, allowing consumers to verify the origin and sustainability of their food. This reduces unethical farming practices and promotes organic, sustainable agriculture. Additionally, real-time tracking of food supply chains helps minimize food waste and optimizes production planning, ensuring sustainable resource management.

SDG 13: Climate Action

By facilitating accurate carbon footprint tracking, blockchain-based agricultural marketplaces support climate-smart farming. Farmers can be incentivized through carbon

credit tokenization, rewarding them for adopting sustainable practices such as regenerative agriculture, soil conservation, and reduced pesticide use. Additionally, blockchain aids in disaster management and climate risk assessment by securely storing and analyzing climate-related agricultural data.

SDG 16: Peace, Justice, and Strong Institutions

A blockchain-based marketplace ensures transparency, trust, and accountability in agricultural transactions. With tamper-proof records, issues like land disputes, fraudulent trading, and unfair pricing are minimized. Additionally, decentralized governance models (DAOs) empower farmers by allowing them to participate in decision-making processes regarding trade policies and regulations.

SDG 17: Partnerships for the Goals

Blockchain fosters collaboration between governments, NGOs, agribusinesses, and small-scale farmers to create a more inclusive and sustainable agricultural ecosystem. By enabling global data-sharing and cross-border transactions, blockchain-based solutions bridge the gap between developed and developing economies, promoting sustainable agricultural development worldwide.

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11. APPENDIX A

https://drive.google.com/drive/folders/1UYOxe01Mectlt0ZzEybpefD8JmoswNeg?usp=drive_link