SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU-572103

(An Autonomous Institute under Visvesvaraya Technological University, Belagavi)

Project Report on

"Revolutionizing Agricultural Dynamics"

submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE & ENGINEERING

Submitted by

Batch No: B15

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2023-24

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CERTIFICATE

Certified that the project work entitled "REVOLUTIONIZING AGRICULTURAL DYNAMICS" is a bonafide work carried out by Chinmay Shankar S. S. (1SI20CS027), Dhanaraj Chandrashekhar Nandikoppa (1SI20CS032), Dhimanth C (1SI20CS033) and Nishanth H. K. (1SI20CS066) in partial fulfillment for the award of degree of Bachelor of Engineering in Computer Science & Engineering from Siddaganga Institute of Technology, an autonomous institute under Visvesvaraya Technological University, Belagavi during the academic year 2023-24. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the department library. The Project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering degree.

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ACKNOWLEDGEMENT

We offer pranams at the lotus feet of **His** Holiness, **Dr. Sree Sree Sivakumara Swamigalu**, Founder President and **His** Holiness, **Sree Sree Siddalinga Swamigalu**, President, Sree Siddaganga Education Society, Sree Siddaganga Math for bestowing upon their blessings.

We deem it as a privilege to thank **Dr. M. N. Channabasappa**, Director, SIT, Tumakuru, **Dr. Shivakumaraiah**, CEO, SIT, Tumakuru, and **Dr. S. V. Dinesh**, Principal, SIT, Tumakuru for fostering an excellent academic environment in this institution, which made this endeavor fruitful.

We would like to express our sincere gratitude to **Dr. N. R. Sunitha**, Professor and Head, Department of CSE, SIT, Tumakuru for her encouragement and valuable suggestions.

We thank our guide **Dr. K. Bhargavi**, Associate Professor, Department of Computer Science & Engineering, SIT, Tumakuru for the valuable guidance, advice and encouragement.

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Abstract

In traditional agriculture, farmers face various challenges in quality analysis of rice grain and transparency in agricultural crop transaction. The reliance on subjective methods for quality assessment often leads to inconsistent results and disputes with purchasers. Additionally, the absence of a reliable system for price negotiation hampers fair transactions. Farmers currently use manual inspection and subjective judgment to assess grain quality, which can be time-consuming and prone to errors. Price negotiation lacks trust and transparency, leading to unfair deals for farmers. Transactions in conventional agricultural practice involve the presence of middlemen, adding another layer of complexity, without ensuring equitable price and transparency across agricultural transaction. The middlemen often dictate prices and terms, further complicating the process for farmers and reducing their control over their crops, without providing a broad market access for them.

This cutting-edge agriculture project overcomes these challenges by leveraging blockchain technology and image analysis. Blockchain ensures transparency and immutability in quality assessment and transaction records, addressing the issue of trust and transparency. Image analysis techniques are used to accurately predict rice grain quality, eliminating the need for subjective assessments. The system provides farmers and buyers with reliable information, empowering them to make informed decisions. Furthermore, the integration of a Legitimate Intermediaries ensures secure and efficient transactions, facilitating fair price negotiation between parties. This innovative approach revolutionizes the traditional supply chain, promoting efficiency, equity, transparency and broad market access for farmer and buyer in agricultural crop transaction.

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Chapter 1

Introduction

Within the great agricultural lands, where the fields themselves tell tales of toil and devotion, a novel project takes root that has the potential to completely alter the structure of the sector. Welcome to the ambitious project, a blockchain symphony that will orchestrate a revolution in justice and transparency along the whole agricultural supply chain. This is to give farmers a control over fair prices in a world where they are often overlooked heroes. This will be achieved by using blockchain technology to disrupt the market and reveal the true nature of every transaction [1].

To transform farmers' perceptions and interactions with their crops is centered on this dedication to open and honest dealings. Farmers can now track the path of their crop from the field to the table by following its trail through an open book that is made possible by the clever integration of blockchain technology. This is a mindset change rather than just a technological advancement, empowering farmers to demand just remuneration and building confidence in the complex dance of agricultural trade [2].

This initiative, though, goes beyond the field, it's about creating inclusive communities. Legitimate intermediaries involved in the array of services, such as packaging, storage and transportation. It's a vibrant community where justice and cooperation are valued, not just a transactional hub. Wherein planting the seeds of togetherness in this agricultural renaissance, building an ecosystem in which each member is not just a shareholder but a vital link in the chain of community-driven wealth. The journey ends not with simple, transparent transactions, but rather with the discovery of an innovative web of interconnected ideas wherein blockchain technology creates a decentralized market. This revolutionary force eliminates Legitimate Intermediaries who prey on others, giving farmers prices that reflect fairness [3].

The expansive vistas of agriculture lies an ambitious initiative poised to redefine the very essence of the industry. A symphony of blockchain technology emerges as a conductor orchestrating a revolution in transparency and fairness throughout the agricultural supply chain. In a realm where the sweat and toil of farmers often fade into obscurity, the mission is crystal clear, to endow them with more than just equitable prices. It's about bestowing upon them control and unveiling the transparency of every transaction through the disruptive force of blockchain [4].

At the nucleus of this endeavor resides an unwavering commitment to transparent transactions, a solemn pledge to revolutionize the way farmers perceive and engage with their harvests. Through the ingenious integration of blockchain, every aspect of the agricultural odyssey metamorphoses into an open narrative, where farmers can meticulously trace the journey of their produce from the verdant fields to the discerning consumer's table. This is not a mere technological innovation, it represents a seismic shift, affording farmers the agency to demand fair compensation and nurturing trust in the intricate choreography of agricultural commerce [5].

Yet, the scope of this project transcends the furrows of the field. It is about cultivating inclusive communities. Avoiding the notion of exclusion, it empowers legitimate intermediaries with a platform that celebrates their multifaceted services. It transcends the realm of being merely a transactional hub. It burgeons into a flourishing community where collaboration and fairness flourish like the vibrant blooms in a well-tended garden. In this agricultural renaissance, the seeds of unity are meticulously sown, nurturing an ecosystem where every participant is not just a stakeholder but an indispensable strand in the rich tapestry of community-driven prosperity [6].

This expedition does not culminate with the mere unraveling of transparent transactions It spread out a tapestry of innovation where blockchain technology itself forges a decentralized marketplace. This transformative force dismantles exploitative intermediaries, endowing farmers with prices that resound with equity like the melodic notes of a harmonious symphony [7].

1.1 Motivation

It motivates to stems from the recognition of the myriad challenges plaguing the agricultural landscape, where the very backbone of the societies farmers often find themselves navigating an intricate labyrinth of opacity and inequity. Witnessing their struggles and the systemic injustices they endure ignited a fervent desire to harness technology not merely for innovation's sake but as a powerful force for positive transformation. The nexus of blockchain emerged as it beacon, offering a paradigm shift that could redefine the entire trajectory of agricultural transactions [7].

At the core of this motivation lies an unwavering commitment to empower farmers with the transparency they deserve. The labyrinthine supply chain, with its opaque pricing mechanisms and uneven power dynamics, compelled us to seek a revolutionary solution. The blockchain technology became the bedrock of this motivation, that could unravel the complexities, laying bare every transaction with a clarity that transcends convention [8].

Additionally, this motivation is a response to the inefficiencies deeply ingrained in human operated, government-regulated systems such as Agricultural Produce Market Committee (APMC), where the very structures designed to support farmers often falter in delivering the fairness they deserve. Witnessing the limitations of these systems, their susceptibility to bureaucratic complexities, and the resultant challenges faced by farmers intensified to resolve and create a transformative solution. The shortcomings of these centralized models served as a clarion call, propelling us to leverage technology not only for innovation but as a means to rectify the systemic imbalances that have long hindered the prosperity of those who till the land [9].

Motivated by a profound recognition of the multiple challenges plaguing the agricultural landscape, this mission is fueled by a deep-seated desire to address the systemic injustices that farmers face. This understanding of the backbone of this societies often grapples with opacity and inequity within a labyrinthine supply chain. Witnessing firsthand the struggles and injustices endured by farmers, it is driven by a fervent commitment to harness technology as a catalyst for positive transformation.

1.2 Objective of the project

The basis of agricultural empowerment is fair pricing, openness, and farmer access to markets. Farmers may prosper economically and reinforce the foundation of the food systems by guaranteeing fair prices. Transparent business practices promote accountability and trust, which are essential for closing the gap between producers and customers. Access to a wide range of markets allows farmers to protect their livelihoods and reach a wider audience. Providing support to authorized middlemen promotes effective commerce while defending the interests of all parties involved. These pillars work together to create a comprehensive framework that strengthens agricultural communities' resilience, encourages sustainability. The objectives of the project are as follows:

- Empower farmer with equitable prices.
- Ensure transparency across agricultural transactions.
- Empower farmers with broad market access.
- Accommodate legitimate intermediaries.

1.3 Organisation of the report

This project report shall be presented in a number of chapters, starting with Introduction and ending with Conclusion. Each of the other chapters will have a precise title reflecting the contents of the chapter. A chapter can be subdivided into sections, subsections and sub subsection so as to present the content discretely and with due emphasis. The project report may be divided into two or more parts, each with an appropriate title. However, the numbering of chapters will be continuous right through. Chapter 1 consists of a complete introduction to this project, which include motivation, and objective of the project. In Chapter 2, a detailed literature review is presented. Chapter 3 gives the overview of the system with software development methodology, functional and non-functional software requirement, system architecture, low level diagrams, implementation details, tools and technology, rice quality analysis and flowchart used in the system. Chapter 4 consists of various parameter under study, detailed outcome of the platform and testing details of the platform and Chapter 5 consists of conclusion of this project and scope for future study. Bibliography cites the various references used for this project.

Chapter 2

Literature Survey

1. A. Subramanian, B. Selvaraj, R. Sivakumar, R. Tabassum and S. Rajaram, "Enhancing Supply Chain Traceability with Blockchain Technology: A Study on Dairy, Agriculture, and Seafood Supply Chains", 3rd International Conference on Pervasive Computing and Social Networking (ICPCSN), 2023, pp. 967-971, doi: 10.1109/ICPCSN58827.2023.00165.

This research explores how blockchain technology might improve openness and accountability in the food supply chain, with particular attention to the dairy, seafood, and agricultural industries. It covers a range of difficulties that arise in these supply chains, including problems with food safety, sustainability, and labor abuses. Three main blockchain-based solutions are suggested by the study: a decentralized, secure system for the agriculture supply chain that uses smart contracts; a blockchain solution to improve accountability and traceability in the seafood supply chain; and a framework to improve traceability in the dairy supply chain. By bridging communication gaps, guaranteeing the accuracy of product origin data [9].

2. Vanditha M, S. R. Hegde, Snehith K, A. S. Prasad and E. A. Madappa, "Agricultural Supply Chain Management System Using Blockchain", International Conference on Recent Trends in Electronics and Communication (ICRTEC), 2023, pp. 1-4, doi: 10.1109/ICRTEC56977.2023.10111914.

This study highlights the potential of blockchain technology to revolutionize information sharing among heterogeneous supply chain players. A innovative solution to effectively track and trace crops while maintaining the highest level of security and streamlining corporate operations is suggested, utilizing smart contracts and the Ethereum blockchain. Blockchain eliminates the need for middlemen, centralized authority, and transaction records, revolutionizing safety and efficiency while maintaining reliability and integrity. Smart contracts are essential to the ecosystem of the agricultural supply chain since they regulate and oversee all participant interactions and transactions [10].

3. M. Surya and S. Manohar, "An Interpretation of the Challenges and Solutions for Agriculture-based Supply Chain Management using Blockchain and IoT", 7th International Conference on Computing Methodologies and Communication (ICCMC), 2023, pp. 1199-1205, doi: 10.1109/ICCMC56507.2023.10083747.

The Internet of Things (IoT) is transforming a number of industries, including supply chain management, healthcare, and smart grids. This paper examines these effects. IoT uses wearables, embedded sensors, and automated systems to improve communication between people and their environment as well as with other people. But as IoT devices proliferate in quantity, variety, and scale, security, authenticity, dependability, and scalability become more difficult to achieve. In order to tackle these obstacles and guarantee the IoT's projected expansion, the research proposes the incorporation of blockchain technology, which has demonstrated efficacy in resolving IoT network concerns. Blockchain improves data collecting, processing, and sharing in terms of trust, immutability, and transparency, especially in the agriculture industry. According to study, precision farming could undergo a revolution when blockchain and the Internet of Things are combined, transforming conventional farms into smart farms with Internet connectivity [11].

4. A. Singh Bist et al, "AI-Enabled Blockchain for Supply Chain in Agriculture", IEEE Creative Communication and Innovative Technology (ICCIT), 2022, pp. 1-5, doi: 10.1109/ICCIT55355.2022.10118743.

This research examines the shortcomings of conventional agricultural supply chain techniques and suggests a revolutionary remedy that combines blockchain and artificial intelligence (AI). The proposed blockchain ecosystem with AI capabilities seeks to transform supply chain management by improving efficiency, traceability, and transparency. The study emphasizes the critical role AI plays, especially in warehousing operations, where it helps with demand forecasts, order revisions, and product rerouting in transit while also optimizing inventory management. The fact that big businesses like Google and Amazon are already making large investments in AI technologies shows how much the industry recognizes AI's potential to change traditional supply chain procedures. In conclusion, the paper makes a strong case for the blockchain ecosystem's novel application in agriculture [12].

5. L. Marchesi, K. Mannaro, M. Marchesi and R. Tonelli, "Automatic Generation of Ethereum-Based Smart Contracts for Agri-Food Traceability System", IEEE Access, vol. 10, 2022, pp. 50363-50383, doi: 10.1109/ACCESS.2022.3171045.

Consumers and governments alike are putting more and more pressure on the agri-food sector to be more transparent. Blockchain technology is being quickly used to address this issue and create safe traceability in the agri-food chain. Because of its immutability and intrinsic trustworthiness, blockchain is a useful tool for combating food fraud and providing information about the provenance of food goods. Nevertheless, creating smart contracts that are suitable for certain use cases is a difficult task. In the agri-food chain, current blockchain-based and smart contract-based management systems are frequently ad hoc and customized for particular goods or procedures, making them challenging to generalize. As a reaction, this article presents a novel method to make Ethereum-based smart contracts for the agri-food industrial area easier to customize and compose. Enabling code and module reuse, automating development procedures, and cutting down on time all while maintaining safety and dependability are the objectives [13].

6. K. Land and A. Siraj, "Blockchain Based Farm-to-Fork Supply Chain Tracking", IEEE International Conference on Big Data (Big Data), 2021, pp. 3416-3425, doi: 10.1109/BigData52589.2021.9671969.

The physical handling of agricultural products by different entities across the supply chain poses hurdles for existing agricultural product tracking systems, making it difficult to trace issues back to their origins effectively. This manual method is not only laborious but also presents security risks pertaining to accountability and data integrity. This work offers a fresh solution to these problems by using blockchain technology to process agricultural data in a decentralized way. Furthermore, it is advised to deploy Internet of Things (IoT) devices for automated data tracking and collection along the entire agricultural supply chain. This study's blockchain-based method provides a controllable, semi-automated system that guarantees the accurate tracking and tracing of agricultural goods. The suggested system seeks to improve integrity and accountability for all parties involved in the agricultural supply chain by utilizing blockchain and IoT, offering a more effective and secure substitute for the current manual tracking techniques [14].

7. G. K. Akella, S. Wibowo, S. Grandhi and S. Mubarak, "Design of a Blockchain-based Decentralized Architecture for Sustainable Agriculture: Research in Progress", IEEE/ACIS 19th International Conference on Software Engineering Research, Management and Applications (SERA), 2021, pp. 102-107, doi: 10.1109/SERA51205.2021.9509044.

Information asymmetry, dependability, and transparency are major issues facing today's centralized ICT-based agriculture systems, which have an effect on vital areas including financial transactions and data sharing in the agricultural industry. Customers and middlemen are among the stakeholders who are becoming more and more concerned with traceability, data transparency, and trustworthy transaction tracking in order to promote smart and sustainable farming practices. This ongoing research endeavors to create a real-time architecture that utilizes decentralized applications and blockchain, acknowledging the revolutionary potential of blockchain technology to effectively address these difficulties. This study focuses on actual application to transform farming techniques towards sustainability and efficiency [15].

8. Shivendra, K. Chiranjeevi, M. K. Tripathi and D. D. Maktedar, "Block chain Technology in Agriculture Product Supply Chain", International Conference on Artificial Intelligence and Smart Systems (ICAIS), 2021, pp. 1325-1329, doi: 10.1109/ICAIS50930.2021.9395886.

Concerns about food safety and corruption threats have caused dynamic changes in the global manufacturing and agricultural production landscapes, which has resulted in a pressing demand for efficient traceability systems in the food and agricultural supply chain. Blockchain technology presents itself as a game-changing tool that can significantly enhance commodity traceability in various supply chains. It is become harder and harder to verify important criteria including origin, development phases, quality requirements, and yield monitoring in today's intricate agricultural supply chains with multiple parties involved. With an emphasis on crop price tracking and attaining complete traceability, this study suggests a novel use of blockchain technology to improve business procedures across the agricultural supply chain. However, this may encounter challenges related to implementation complexity, energy consumption, transaction processing speed, and regulatory compliance, potentially impeding its widespread adoption and effectiveness [16].

9. Rongkuan Wang and Xi Chen, "Research on Agricultural Products Supply Chain Traceability System", IEEE International Conference on Consumer Electronics - China (ICCE-China), 2022, DOI: 10.1109/ICCE-China54655.2022.9861330.

Enhancements to the blockchain consensus method PBFT (Practical Byzantine Fault Tolerance) are presented in this paper to improve the veracity and integrity of agricultural product traceability data. Acknowledging the inefficiencies and communication overhead of the PBFT consensus process in a coalition blockchain, an enhanced algorithm called FPBFT is suggested as a remedy. Based on their actions, nodes' credibility is evaluated during the consensus process by computing a credit value. After then, nodes are given different voting rights based on how much credit they have. To mitigate temporal complexity, a reduced consistency protocol is proposed that takes advantage of the properties of nodes in the coalition chain. The ultimate goal is to apply this improved blockchain consensus algorithm to streamline the entire process traceability system, from the planting stage to the consumption of agricultural products. However, its reliance on node behavior for credit calculation may introduce subjective biases, and simplifying the consistency protocol could potentially compromise the integrity and reliability of the blockchain system [17].

10. Alireza Sedghi, Mohammadreza Taghizadeh, Ali Gholampour and Mohammad Hashemi, "Food Supply Chain Traceability System using Blockchain Technology", 8th International Conference on Signal Processing and Communication (ICSC), 2022, DOI: 10.1109/ICCCS53172.2022.9684469.

The Food Supply Chain (FSC) is examined in detail in this article, with a focus on quality, safety, ethical consumption, and regulatory compliance. Acknowledging the substantial impact of the agriculture sector on a country's GDP, the research suggests utilizing blockchain technology to improve the current FSC. Through the utilization of blockchain's decentralized structure, immutability, security, and smart contract functionalities, stakeholders can cultivate confidence and tackle present supply chain problems. The main goal of applying blockchain technology is to improve the food supply chain's overall sustainability and efficiency. The paper also explores the real-world implementation of sophisticated algorithms, offering a thorough description of the proposed Food Supply Chain Monitoring System and it offers a thorough rundown of the suggested Food Supply Chain [18].

11. A. M. Khan, M. U. Khan, M. Shahzad and M. A. Hashmani, "Blockchain based Smart Model for Agricultural Food Supply Chain", IEEE International Conference on Computer and Communication Systems (ICCCS), 2020, DOI: 10.1109/ICCCS49818.2020.9246540.

The article emphasizes how crucial it is to monitor every step of the handling, preparing, and storing of food in order to reduce the possibility of infections brought on by sloppy work or inadequate management. It promotes the use of smart agricultural systems, which are better capable of addressing these issues than current ones. The process that describes how food produced on farms gets to consumers is called the agricultural food supply chain. The study offers a clever strategy for integrating blockchain technology into conventional food supply chains to alter them. By utilizing blockchain technology, this concept seeks to create a food supply chain system that is effective, hygienic, and secure. The approach is noteworthy for its ability to provide equal possibilities to all parties involved in the agricultural food supply chain, regardless of their acquaintance with one another, without depending on a third-party service provider that can be trusted. However, reliance on blockchain technology may introduce barriers for stakeholders unfamiliar with the technology, potentially hindering widespread adoption and implementation, challenges may arise in terms of scalability, integration complexity [19].

12. A. Z. M. Touhidul Islam, Muhammad Shahzad and Muhammad Asif Khan, "Agricultural-based Food Visibility and Traceability System using Blockchain Technologies", 8th International Conference on Communication and Electronics Systems (ICCES), 2023, DOI: 10.1109/ICIT57473.2023.9755158.

The article emphasizes agricultural-based food visibility and traceability systems, the study highlights the importance of these systems in tracking food production and distribution from the farm to the final consumer. Food can be tracked using these systems from its point of origin to its final destination a restaurant or grocery store, for example. These systems' main goals are to ensure food security, prevent adulteration, and reduce food waste. Furthermore, the traceability feature makes it possible to promptly identify and address any possible problems pertaining to food items. A food visibility and traceability system gives customers assurances about the quality, safety, and freshness of the food they buy [20].

13. Chen Shengfeng, Zhou Linl and Fan Zehua, "Research on the construction of agricultural product quality and safety traceability platform based on blockchain technology", IEEE International Conference on Consumer Electronics - China (ICCE-China), 2021, DOI: 10.1109/ICCEChina54655.2022.986-132.

The low credibility, incomplete data, and inefficiency of the current centralized agricultural product traceability system are discussed in the study. A blockchain-based agricultural product quality and safety tracking platform is introduced in order to address these issues. The blockchain implementation used by the platform is Hyperledger, which is set up with several organizational nodes. Java is used to write the server and client programs, whereas Go is used to write the chain codes. The traceability chain is constructed with each link's operation information meticulously recorded, and it is based on sequential link relationships. Multiple departments from different companies might take part in the same traceability chain at the same time. Real-time uploads of agricultural product traceability data are made to the distributed ledger. Real-world testing has shown that the platform has been introduced and is operating steadily. However, the reliance on multiple organizational nodes and different programming languages for implementation could introduce complexities in maintenance and potential compatibility issues [8].

Chapter 3

Design and Implementation Details

3.1 Software Development Methodology

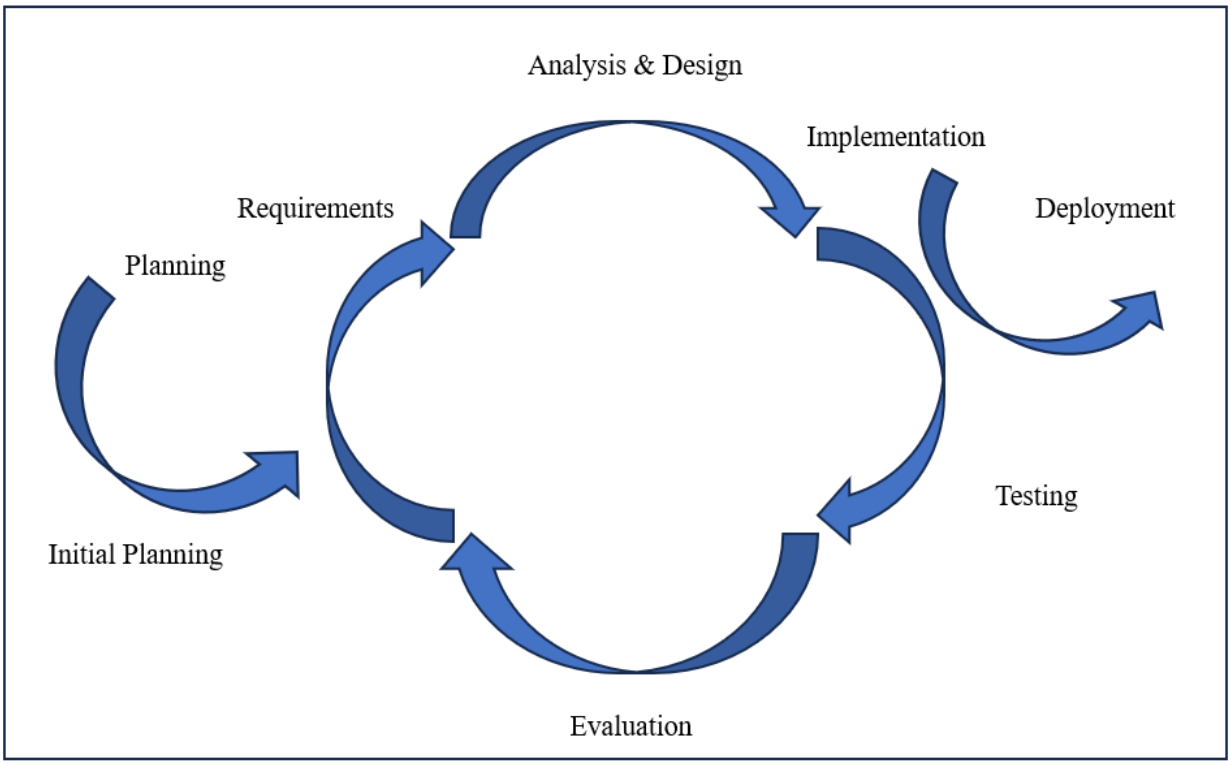

Figure 3.1: Iterative model representing various phases of software development.

As shown in Figure 3.1, the process of developing the integrated agriculture platform would entail several cycles, or iterations, within the framework of an iterative model, with each cycle concentrating on a distinct area of development and improvement. The process would initially start with a planning stage where the platform's criteria and general goals are established. This will entail carrying out in-depth study on market dynamics, technology advancements, and farmer demands. Throughout the development phase, these criteria can be continuously refined and feedback can be provided because to the iterative nature of the model. The platform's methodological framework would then be designed during the first iteration. This entails laying out the subsequent steps that must

be followed, like designing the database and integrating blockchain technology, as well as making sure that it is scalable and accessible.

These components would be implemented and improved upon in later iterations. The technique, for instance, would cover the planning and execution of a strong Database Management System (DBMS) that can effectively manage substantial amounts of agricultural data. The process would entail cyclical cycles of data modeling, testing, and optimization to guarantee that the database management system satisfies the platform's needs for data storage and dynamic pricing calculations. Comparably, integrating blockchain technology would be done in phases, beginning with strategy and research and moving through implementation, testing, and improvement. Every iteration would concentrate on distinct facets of blockchain integration, like security, transparency, and scalability, with stakeholder feedback guiding ongoing development. The technique would also include strategies for guaranteeing scalability, accessibility, and collaboration with approved intermediaries [13].

3.2 Software Requirements

3.2.1 Functional Requirements

The functional specifications for the agricultural dynamics revolutionization system driven by blockchain are made to maximize efficiency and transparency while addressing major issues in the agricultural supply chain. Stakeholders may follow products from manufacturing to consumption by putting traceability and transparency measures in place, which promotes trust and educated decision-making. By automating agreements, smart contract integration lowers costs and resolves disputes while maintaining secure transactions. Stakeholder interaction is encouraged and confidentiality and integrity are preserved via strong data management and sharing mechanisms.

By authenticating participants and items, authentication procedures improve security and trust. Blockchain technology is used in supply chain optimization to identify and fix inefficiencies in real time, boosting output and cutting waste. Scalability and performance guarantees that the system can meet increasing needs without compromising speed or

dependability, while user-friendly interfaces encourage stakeholder uptake and participation. The ability to integrate seamlessly with current systems improves compatibility and data transfer within the agricultural infrastructure.

• **Traceability and Transparency:** Putting in place systems to monitor agricultural products from the point of production to the point of consumption, guaranteeing transparent and verifiable data to build confidence and promote well-informed decision-making along the supply chain.

• **Smart Contract Integration:** Use smart contracts to automate and enforce agreements between supply chain partners, cut costs, minimize conflict, and guarantee safe and effective transactions without the need for middlemen.

• **Data Management and Sharing:** Utilizing blockchain technology to safely store, manage, and distribute agricultural data while promoting stakeholder engagement and openness and guaranteeing data accessibility, confidentiality, and integrity.

• **Authentication and Verification:** Putting in place strong processes to confirm the authenticity and identification of participants and goods in the agricultural ecosystem, improving security and building confidence.

• **Supply Chain Optimization:** Using blockchain technology to optimize operations including distribution, logistics, and inventory management; detecting and resolving inefficiencies instantly to increase productivity and cut down on waste.

• **User Interface and Experience:** Creating user-friendly interfaces that are easy to use and intuitive to connect with the blockchain-based agricultural platform, encouraging stakeholder uptake and engagement.

• **Scalability and Performance:** Ensuring that the system can manage growing numbers of users and transactions while keeping high performance and availability and without sacrificing speed or dependability.

• **Interoperability with Existing Systems:** Ensuring compatibility and smooth interoperability by facilitating data interchange and seamless integration between the blockchain system and the current agricultural infrastructure.

3.2.2 Non Functional Requirements

Security, scalability, reliability, performance, usability, interoperability, and maintainability are critical pillars of the blockchain-powered agricultural dynamics revolutionization system. Emphasizing robust security measures ensures protection against tampering, unauthorized access, and cyber threats through stringent authentication procedures and access restrictions. Scalability is vital to accommodate increasing transaction volumes and user interactions without compromising efficiency or dependability, necessitating scalable architecture and effective resource allocation. Reliability is paramount, requiring comprehensive disaster recovery plans and fault tolerance methods to ensure consistent operation even during unforeseen events. High-performance features prioritize efficiency and responsiveness, achieved through refinement technique and network optimization. User-centric design promotes usability, making the system accessible and intuitive for stakeholders with varying technical skills.

• **Security:** To protect sensitive information, transactions, and communications, the system must place a high priority on strong security measures. To reduce the risks of tampering, illegal access, and cyber threats, this entails putting in place strong authentication procedures, access restrictions, and thorough audit trails.

• **Scalability:** Ensuring that, without sacrificing efficiency or dependability, the system can grow to handle rising transaction volumes, data storage needs, and user interactions. In order to maintain optimal performance and accommodate growth and peak loads, scalable architecture, effective resource allocation, and load balancing techniques are required.

• **Reliability:** Under both regular and peak operating conditions, the system must operate consistently and dependably with little interruptions or downtime. In order to accomplish this, it should have comprehensive disaster recovery plans, redundancy, and fault tolerance methods to guarantee data integrity and continuing operation even in the face of unforeseen occurrences or failures.

• **Performance:** Setting high performance features as a top priority in order to satisfy user demands for efficiency, throughput, and responsiveness. In order to provide optimal performance across a range of workload scenarios, this entails refining technique, data structures, and network settings to minimize latency and enhance system efficiency.

• **Usability:** Putting a strong emphasis on user-centric design concepts to make sure

stakeholders with differing degrees of technical skill can easily understand and operate the system. To promote smooth engagement and adoption, user interfaces should be accessible, clear, and easy to use with well-defined navigation and instructions.

• **Interoperability:** Facilitating easy interoperability and interaction with current databases, technology, and agricultural systems. Collaboration and interoperability are promoted by adhering to industry standards, protocols, and interfaces, which guarantee seamless data flow and interaction between the blockchain-based system and external systems.

• **Maintainability:** Making it easier to maintain, update, and modify in order to adapt to changes and advancements throughout time. This entails using version control systems, thorough documentation, and a modular design approach to allow continuous development and optimize maintenance activities.

3.3 High Level Design

3.3.1 System Architecture

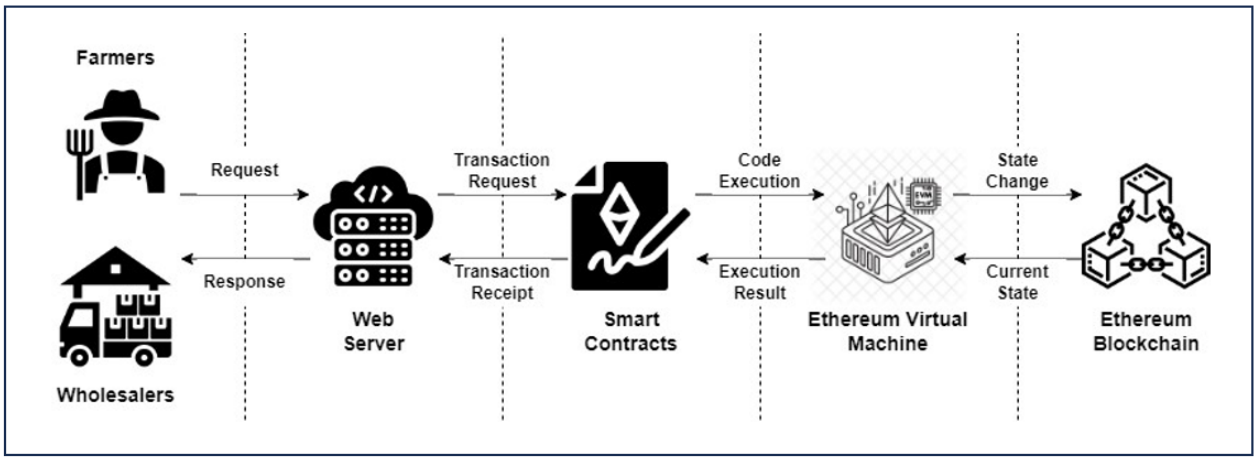

Figure 3.2: System architecture of blockchain based agricultural product transaction.

As shown in Figure 3.2, In the agricultural transaction process facilitated by the blockchain-powered system, the journey begins when a farmer submits a sale request through the web server. This triggers a series of efficient and technologically advanced procedures, starting with the initiation of smart contracts on the Ethereum Blockchain. The Ethereum Virtual Machine executes transaction requests, updating the blockchain with the modified state after processing. Once the Ethereum Virtual Machine completes its execution, it

communicates the result back to the Ethereum Blockchain, which generates a transaction receipt sent to the web server. Finally, the web server responds to the farmer and informs wholesalers of the successful transaction, marking the completion of the process. Through this streamlined and transparent process, the system ensures trust, efficiency, and fairness in agricultural transactions.

Farmer Request: The web server receives a sale request from the farmer. The moment a farmer sends out a request via the web server to sell their produce, a more efficient and technologically advanced transaction procedure begins.

Smart Contracts Processing: The Ethereum Blockchain's smart contracts receive the request from the web server.An important point in the agricultural transaction process is the "Smart Contracts Processing" step. The web server automatically forwards the farmer's sale request to the Ethereum Blockchain's smart contracts as soon as the web server receives it.

Ethereum Virtual Machine Execution: The Ethereum Virtual Machine processes transaction requests, resulting in state modifications. A crucial stage in the agricultural transaction process is the "Ethereum Virtual Machine Execution" phase, which comes after the farmer's sale request is initiated and pertinent data is processed by smart contracts.

Blockchain Update: Returned to the Ethereum Blockchain is the updated state.An important stage in the agricultural transaction process is the "Blockchain Update" phase, which happens after the Ethereum Virtual Machine has carried out the transaction logic in response to the farmer's sale request.

Result to Ethereum Virtual Machine: The Ethereum Virtual Machine receives the current state from the Ethereum Blockchain.The "Result to Ethereum Virtual Machine" phase entails communicating the current state back to the Ethereum Virtual Machine after the transaction logic has been executed on it.

Execution Result: Ethereum Virtual Machine offers the execution result after process-

ing the state.Following the receipt of the current state from the Ethereum Blockchain by the Ethereum Virtual Machine, the agricultural transaction process reaches a critical juncture that is represented by the Execution Result phase.

Transaction Receipt: A transaction receipt is created by smart contracts and sent to the web server. An important stage in the agricultural transaction process is the "Transaction Receipt" phase, which happens after the Ethereum Virtual Machine has assessed the execution outcome.

Web Server Response: The web server replies to the farmer and lets the wholesalers know that the transaction went through.The "Web Server Response" phase, which follows the smart contracts' creation of the transaction receipt, is the last stage of the agricultural transaction process.

3.4 Low Level Design

3.4.1 Use Case Diagram

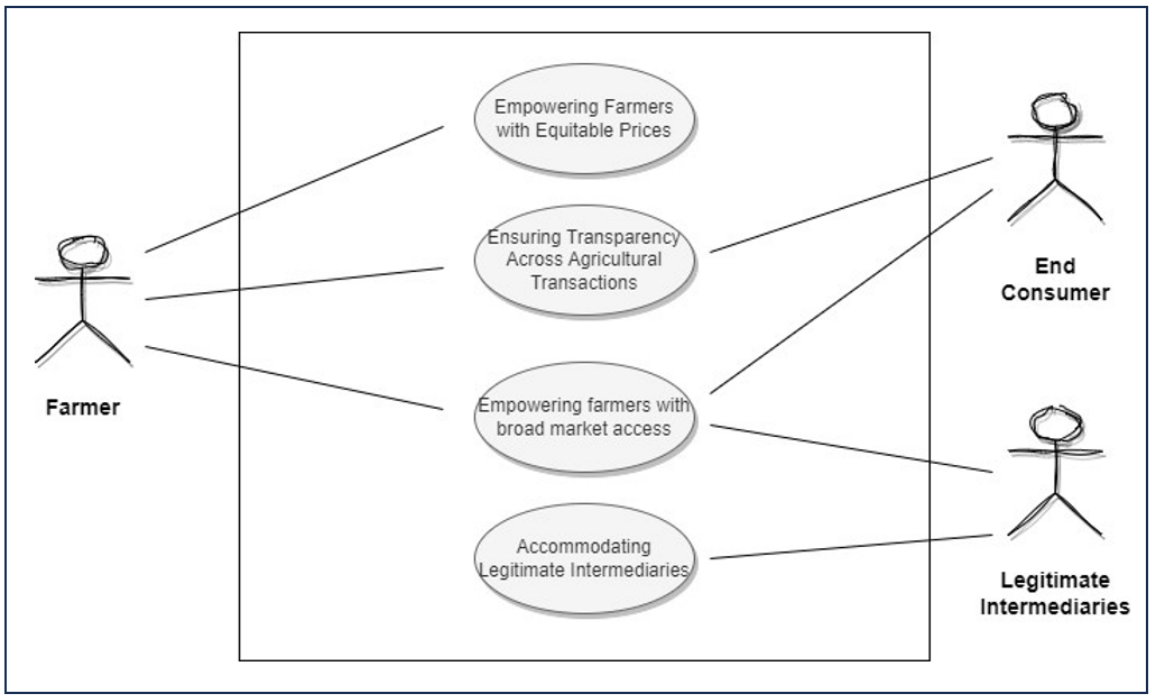

Figure 3.3: Use case diagram of interactions between farmer, buyer and intermediaries.

As shown in Figure 3.3, the blockchain-powered agricultural dynamics revolutionization system is designed to empower farmers by ensuring fair compensation, fostering transparency for both end consumers and farmers, providing broad market access, and accommodating legitimate intermediaries. Through market intelligence and sophisticated pricing, farmers receive equitable rates for their produce, addressing historical compensation disparities. Transparency is enhanced through blockchain integration, offering consumers comprehensive product information and instilling trust in the supply chain. The platform's accessibility and user-friendly interfaces broaden market reach for farmers, while facilitating seamless participation for legitimate intermediaries promotes efficiency and collaboration throughout the agricultural value chain.

Empowering Farmers: The platform uses market intelligence and sophisticated pricing, to guarantee that farmers get fair rates for their produce. The historical issue of farmers not being fairly compensated for their agricultural labor is addressed by this empowerment.

Transparency for End Consumers and Farmer: The software creates a safe and unchangeable ledger by integrating transparent technologies like blockchain. By giving end users a comprehensive picture of the product's origin, manufacturing methods, and cost, this transparency fosters trust in the agricultural supply chain and gives consumers peace of mind.

Broad Market Access for Farmers: The platform, which is made to be easily accessible, gives farmers access to a wider market. Farmers may exhibit their products to a larger audience with the help of user-friendly interfaces and multi-platform compatibility, which improves market visibility and boosts sales prospects.

Accommodating Legitimate Intermediaries: Within the platform, legitimate middlemen like distributors or brokers are welcomed. The way the system is set up makes it easier for them to participate, which encourages efficiency and teamwork along the agricultural value chain.

3.4.2 Sequence Diagram

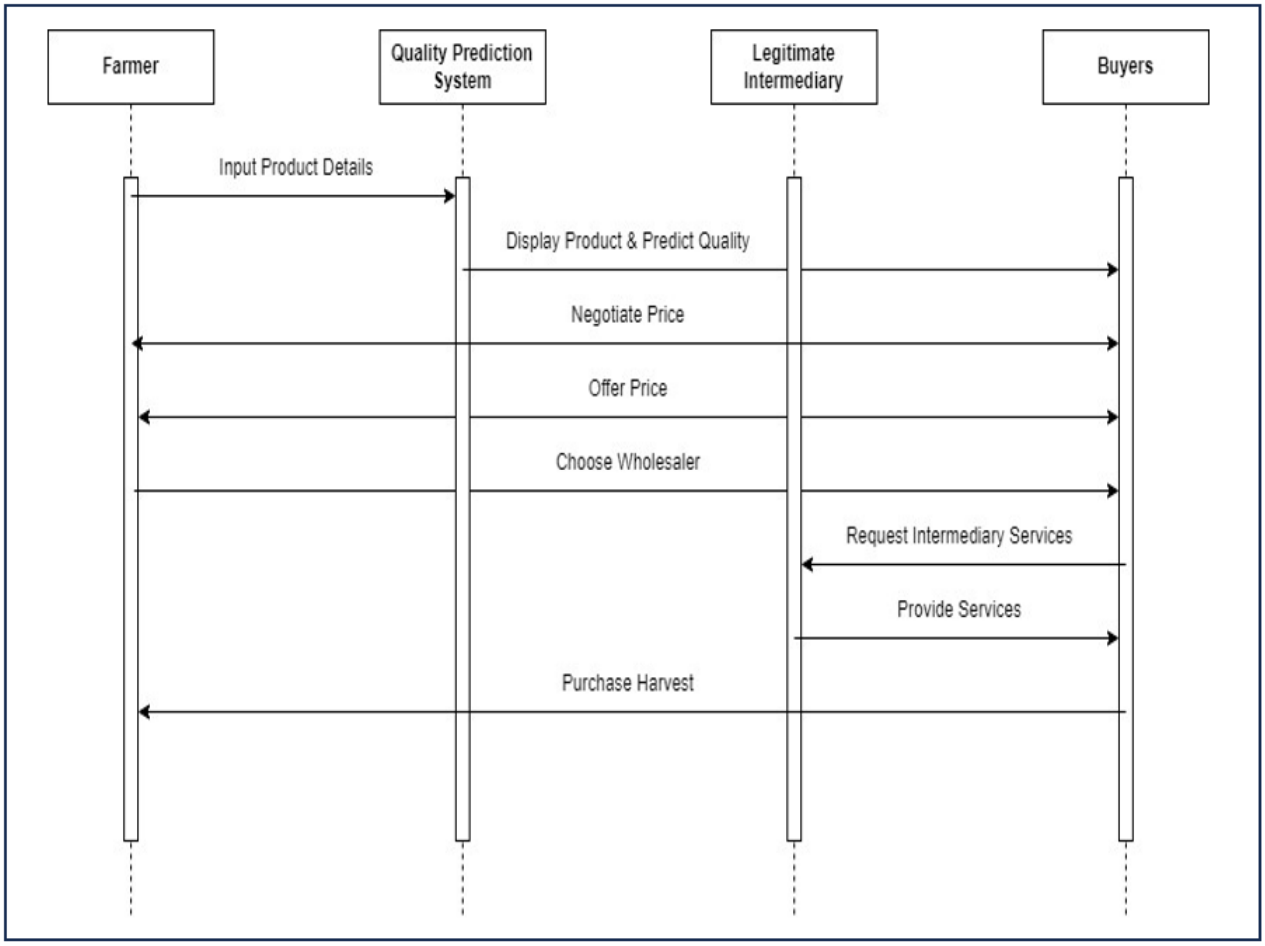

Figure 3.4: Sequence diagram of agricultural product transaction.

As shown in Figure 3.4, farmers enter information about their agricultural products into this system, and a quality analysis engine uses this data to assess the product's quality. The quality assessment that is produced is then made available to the farmer and possible customers via an interface. This guarantees a fair and knowledgeable negotiation by enabling the farmer and the buyer to have conversations and come to a mutually acceptable price. A trustworthy middleman intervenes to help the buyer receive the goods from the farmer, streamlining the entire transaction. As a reliable facilitator throughout the transaction, this middleman is essential to guaranteeing the product's seamless transition from the farmer to the customer. Through aiding both sides, the middleman promotes a just and beneficial procedure that strengthens confidence and collaboration across the agriculture supply chain.

3.5 Implementation

The blockchain-powered agricultural dynamics project to address the existing challenges within the agricultural supply chain by leveraging the transparency, traceability, and equitable pricing mechanisms offered by blockchain technology. Through meticulous project scope definition, the precise objectives, requirements, and features of the system will be outlined, ensuring clarity and alignment with stakeholder needs. Market research will be conducted to identify shortcomings in current supply chain management practices, allowing for the development of a competitive edge and informed decision-making regarding budget and schedule allocation.

Target market identification will involve understanding the diverse needs of consumers, producers, and intermediaries, ensuring the system is designed to be usable and relevant to end users. A skilled development team, proficient in blockchain technology and agribusiness, will be assembled to guarantee the accuracy and quality of the system. A comprehensive project schedule and budget will be created, allocating resources efficiently and accounting for potential risks such as regulatory changes and technological challenges. Infrastructure for project tracking and assessment will be implemented to monitor progress, adjust plans as needed, and ensure the project's goals are achieved within the specified timeline and budget.

• **Project Scope Definition:** Clearly define the objectives, requirements, and requirements of the blockchain-powered agricultural dynamics revolutionization system. In doing so, the system's precise goals, features, and attributes such as traceability, transparency, and equitable pricing mechanisms within the agricultural supply chain will be outlined.

• **Market Research:** To determine the current shortcomings in agricultural supply chain management and to comprehend the distinctive features of the suggested blockchain-based solution, conduct in-depth market research. Examine alternative agricultural management systems' characteristics and capabilities to get a competitive edge and provide guidance for the project's budget and schedule.

• **Target Market Identification:** Determine the intended audience for the blockchain-based agriculture system while taking into account the demands and specifications of various stakeholders, including consumers, producers, and legitimate intermediaries. Make

sure the system is usable, accessible, and relevant by designing it to satisfy end users' needs.

• **Development Team Selection:** Put together a knowledgeable development team with specialists in blockchain technology, agribusiness, and software development. Ascertain that team members have the necessary training and experience to ensure the system is accurate and of high quality.

• **Project Schedule Creation:** Create a thorough project timeline that includes due dates for all phases, such as development, testing, design, and deployment. Establish milestones and distribute resources wisely to guarantee the project is finished on schedule.

• **Budget Creation:** Create a thorough budget that includes all project-related costs, such as those for testing, software, hardware, and maintenance. Provide enough money for every task and budget for any unanticipated costs that might come up while the project is being carried out.

• **Risk Management Strategy:** To identify, evaluate, and reduce possible risks that could affect the project such as changes in regulations, worries about data security, or technological difficulties develop a risk management strategy. Put precautions in place to deal with hazards ahead of time and guarantee project success.

• **Infrastructure for Project Tracking and Assessment:** Provide a strong system for monitoring and evaluating the project's advancement over its whole duration. Use tools and processes to keep an eye on key performance indicators, make necessary adjustments to plans, and ensure that the project's goals, timeline, and budget are all satisfied.

3.5.1 Tools and Technologies

The system leverages Ethereum Blockchain for secure and transparent agricultural transactions through smart contracts, ensuring confidence and reliability without middlemen. Solidity programming language enables the creation of sophisticated smart contracts tailored to agricultural needs, ensuring precision and effectiveness. React.js is utilized for dynamic front-end development, providing a responsive user interface that enhances engagement. Node.js powers the scalable and real-time server-side functionality, facilitating seamless data flow and communication. Web3.js enables easy interaction with the Ethereum Blockchain, improving system dependability. InterPlanetary File System (IPFS) ensures data integrity by decentralizing file storage, enhancing security and resilience. A Cascading Style Sheet (CSS) framework is employed for visually appealing user interface design, prioritizing aesthetics and usability to increase user satisfaction and platform acceptance.

Blockchain Technology

• **Ethereum Blockchain:** The Ethereum Blockchain, a decentralized platform well-known for its smart contract capabilities, is utilized by the system. Ethereum ensures confidence and reliability in agricultural transactions by facilitating safe and transparent transactions without the need for middlemen. Because it is decentralized, there is less chance of fraud or manipulation and data integrity is improved.

• **Solidity Programming Language for Smart Contracts:** Solidity is used to program smart contracts, the foundation of blockchain-based systems. With this high-level language, developers can create and run self-executing contracts on their own. Because of its strength, Solidity may be used to create sophisticated smart contracts that are specifically designed to meet the needs of agricultural transactions. This guarantees precision and effectiveness while carrying out agreements.

Web Development

• **Front-end - React.js:** The front-end development uses React.js, which provides a responsive and dynamic user interface. Its component-based design makes it easier to create and maintain user interface elements, which speeds up development and promotes smooth user interactions. React.js makes surfing easy and straightforward, which increases user

engagement.

• **Back-end - Node.js:** The server-side functionality of the system is powered by Node.js, which provides scalability and real-time capabilities. Because of its event-driven architecture, concurrent requests may be handled effectively using non-blocking, asynchronous processing. Node.js facilitates easy data flow and layer-to-layer communication by enabling seamless integration with other system components.

• **Interaction with Ethereum Blockchain - Web3.js:** The Ethereum blockchain is accessed with Web3.js, which makes it possible to incorporate blockchain functionality into a web application with ease. This JavaScript library offers Application Programming Interface (API) to communicate with Ethereum nodes, enabling the implementation of smart contracts, the execution of transactions, and the retrieval of blockchain data. By facilitating safe and effective connection with the Ethereum network, Web3.js improves the system's dependability and performance.

Data Management

• **InterPlanetary File System (IPFS) for Data Integrity:** In the system, IPFS is used to guarantee data integrity. By distributing and decentralizing file storage across a network of nodes, IPFS improves redundancy and removes single points of failure. By reducing the possibility of data loss or manipulation, this decentralized method improves data security and resilience.

User Interface Design

• **CSS Framework for Visually Appealing User Interface (UI):** To create a user interface that is both aesthetically pleasing and easy to use, a CSS framework is employed. With the help of the framework's pre-designed elements and styling options, developers may produce UI designs that are aesthetically beautiful and consistent. The system prioritizes aesthetics and usability in order to increase user pleasure and engagement, which will ultimately lead to platform acceptance and usage.

3.5.2 Rice Quality Analysis

The technique utilized in rice quality analysis assesses rice grains and provide valuable insights to support agricultural decision-making and ensure quality control procedures. As shown in Figure 3.5, this techniques is utilized in the field of rice quality analysis to evaluate the attributes of rice grains. This includes counting and classifying the grains according to metrics like length, breadth, and length-breadth ratio. These metrics support agricultural decision-making and quality control procedures by offering insightful information about the properties and quality of rice grains. The steps are as follows:

Pre-Processing: Noise reduction and picture registration are the initial steps in the image processing pipeline. The process of picture registration guarantees uniformity and alignment among various images, whereas noise removal eliminates undesired patterns or anomalies that could potentially skew the analysis outcomes.

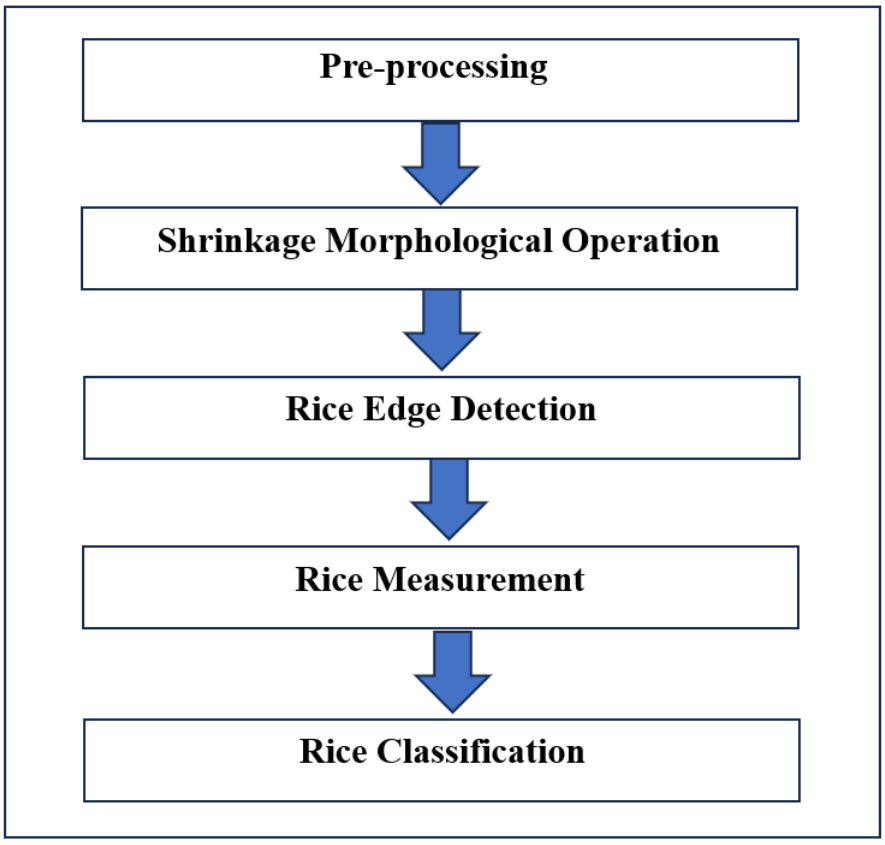

Figure 3.5: Flow diagram for rice quality analysis.

Segmentation: After pre-processing, shrinkage methods are used to segment the image in order to tackle the problem of touching rice kernels. By separating the individual rice grains from one another, this procedure makes precise measurement and analysis possible.

Edge Detection: In the segmented image, the boundaries of the rice grains are found using edge detection. This stage makes it possible to distinguish rice grains precisely, which facilitates measurement and classification accuracy.

Measurement: The next step is rice seed measurement, in which each rice grain's length, width, and length-to-breadth ratio are measured. These measures offer numerical information on the physical properties of the rice grains, which serves as the foundation for quality evaluation and classification.

Classification: Lastly, the size and form of the rice grains are used to categorize them. The grains are divided into various categories by this classification procedure based on predetermined parameters like length, width, and length-to-breadth ratio. Informed decision-making in agricultural practices is facilitated by this phase, which gives farmers and other stakeholders the ability to recognize and distinguish rice grains according to their qualitative qualities.

All things considered, the use of image processing methods in rice quality analysis provides a thorough method for evaluating and classifying rice grains according to their physical attributes. Image processing helps to increase agricultural output and guarantee that consumers receive high-quality rice products by automating the analysis process and offering quantitative data on grain quality.

3.5.3 Flowchart

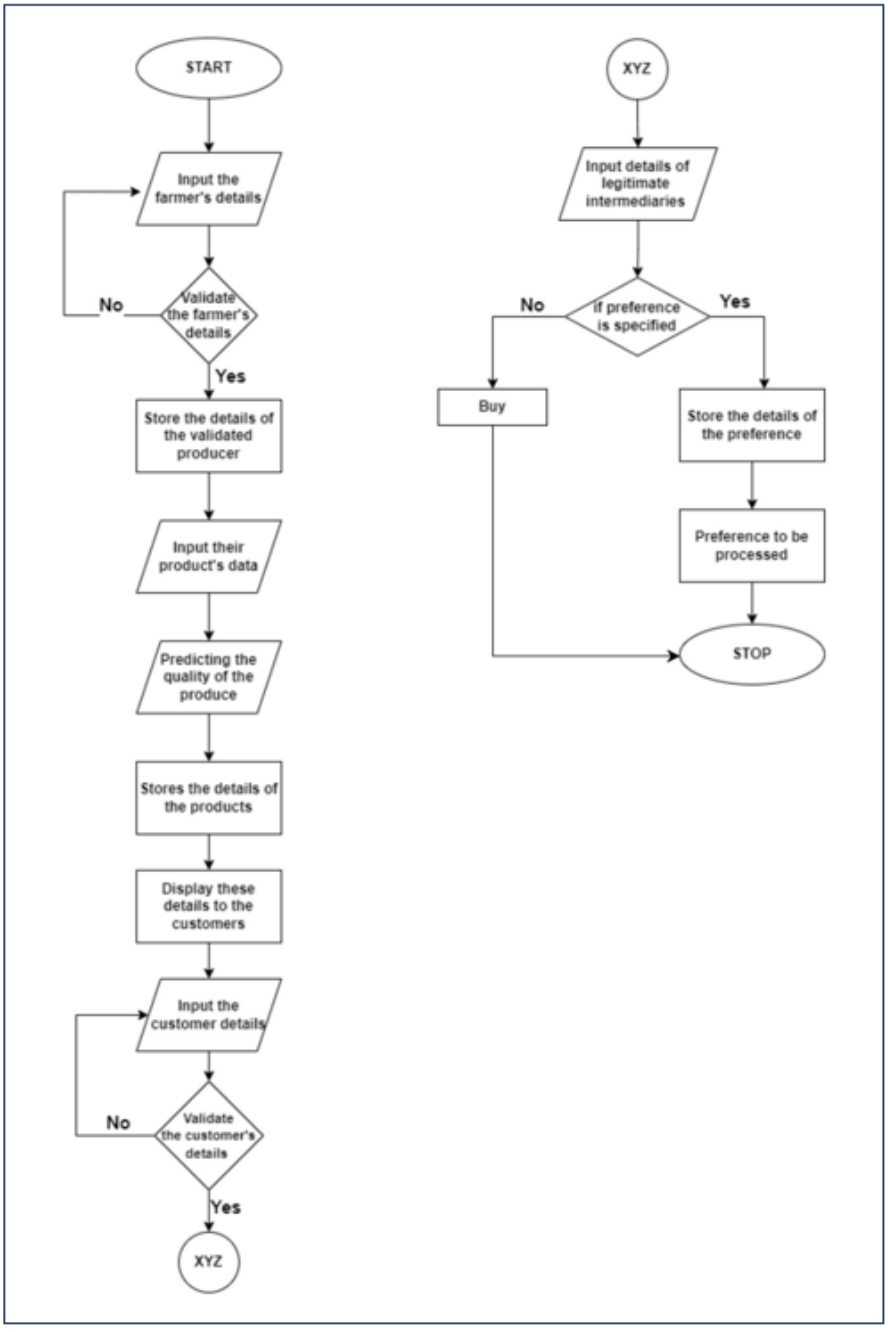

Figure 3.6: Flowchart representing flow of agri-product.

As shown in Figure 3.6, the farmer initiates the process by entering vital data into the system about themselves and their produce. This contains information about who they are, how to get in touch with them, and the particulars of the produce they are selling. Simultaneously, the consumer interacts with the system by supplying legitimate personal data, including name, contact details, and potentially preferences or specifications related

to the item they plan to buy. At this point, the system makes use of sophisticated analysis technique to evaluate the information supplied by the farmer on the attributes of the product, the sourcing procedures, and other relevant aspects in order to precisely forecast its quality. Simultaneously, the authorized middlemen engaged in the deal enter their legitimate credentials and pertinent data into the system, guaranteeing accountability and transparency all the way through.These particulars, which include those of the farmer, the customer, and the middlemen, are safely kept in the database of the system, providing the groundwork for a reliable and effective transactional environment.

The technology then shows the consumer detailed information about the farmer's products after the data input stage. This comprises the quality analysis produced by the system on the basis of its analysis, in addition to the fundamental information supplied by the farmer. Equipped with this data, the buyer can decide for themselves whether or not to move through with the transaction. If they decide to proceed, the system provides two different acquisition routes. First, the client has the option to hire reputable middlemen to help with different parts of the deal, such shipping, quality control, or bargaining; all related expenses should be disclosed in advance.As an alternative, the buyer maintains the independence to finish the purchase on their own, bearing all costs and obligations associated with the procurement procedure. This adaptable strategy promotes confidence and openness in the agricultural industry while allowing customers to customize their purchasing experiences to suit their needs and tastes.

Chapter 4

Results

In this study, the system's efficacy and efficiency in transforming agricultural dynamics are assessed from multiple angles. First, to ensure smooth interactions for farmers, buyers, and authorized intermediaries, the platform's usability and functionality are evaluated. To guarantee a satisfying user experience, this entails assessing the accessibility features, navigation flow, and user interface design. In addition, the system's performance under high-load scenarios is assessed to guarantee maximum throughput, scalability, and responsiveness particularly in times of elevated transaction volumes. In addition, the system's security and integrity are assessed to protect sensitive data, user accounts, and transactions against manipulation or unauthorised access. To reduce potential risks and weaknesses, this entails putting strong authentication systems, encryption protocols, and security assessments into place.

This project aims to comprehensively evaluate the effectiveness, usability, and performance of the proposed system enhancements by utilizing a variety of comparison approaches, including before and after implementation, benchmarking against industry standards, comparative analysis with existing solutions, and user feedback and satisfaction. A thorough evaluation will be achieved. With the help of these comparisons, we can evaluate the system's competitiveness, adherence to industry standards, and compatibility with user expectations. This information helps us make decisions about system enhancements and guarantees that the agricultural sector's stakeholders will receive a solution that suits their needs and preferences.The cases of comparison are:

Before and After Implementation: This comparison evaluates the effectiveness, usability, and performance of the system both before and after the suggested fixes are put into place. It aids in calculating the effects of system enhancements and modifications.

Benchmarking Against Industry Standards: To assess the system's competitiveness and conformity to accepted norms, its functionality and performance are measured against industry standards and best practices.

Comparative Analysis with Existing Solutions: To determine the advantages, disadvantages, and potential areas for development of the suggested solutions, they are contrasted with current technologies or systems. The uniqueness and value proposition of the suggested solutions are ascertained with the use of this study.

User Feedback and Satisfaction: The system's user happiness and feedback are compared before and after the suggested fixes are put into practice. This comparison aids in determining how users view, accept, and feel about the system modifications that have been implemented.

Performance metrics are crucial indicators that are used to evaluate a system's efficacy and efficiency. These metrics offer important insights into the functionality and dependability of the system. Examples of these indicators are transaction throughput, transaction speed, data integrity, system uptime, security compliance, scalability, user engagement, and cost efficiency. Our project intends to assure maximum functionality, user satisfaction, and overall success in transforming agricultural dynamics through the monitoring of key variables.

System Uptime: Determines the proportion of time that the system is up and running and accessible to stakeholders, providing a measure of its dependability and accessibility.

Security Compliance: Assesses how well the system adheres to security guidelines and procedures to guard against breaches or illegal access to user information and transactions.

Scalability: Evaluates the system's capacity to handle growing user numbers, transaction volumes, and data volumes without compromising dependability or performance.

User Engagement: indicates user happiness and adoption rates by measuring the de-

gree of engagement and participation of stakeholders within the system.

Every metric that this project is examining is vital to assessing the efficacy and performance of the agricultural supply chain platform. Transaction speed guarantees that transactions are completed on time, whereas transaction throughput gauges how well the platform can handle a large number of transactions. The list of parameter under study are described below.

Transaction Throughput: This quantity, which is commonly defined in Transactions Per Second (TPS), describes how many transactions the platform can perform in a specific amount of time. Transaction throughput is essential to this project because it guarantees that the platform can effectively manage a high volume of transactions, including payments, agreements, and product orders.

Transaction Speed: The time it takes for a transaction to be verified and completed on the blockchain is measured by transaction speed. Transaction speed is essential to this project because it allows stakeholders to engage promptly and effectively, especially during crucial stages like negotiations and real-time data updates.

Data Integrity: Data integrity guarantees the accuracy, consistency, and security of the information communicated, stored, and handled within the platform. Upholding data integrity is critical to this project's goal of fostering stakeholder confidence and guaranteeing the accuracy of information utilized in decision-making.

This project's experimental setup entails setting up hardware and software components, creating a controlled test environment to mimic real-world circumstances, creating and gathering data on the agricultural supply chain, planning experiments with predetermined variables and performance metrics, and rigorously testing and verifying the system to ensure its efficacy. Our solution can be thoroughly evaluated and improved thanks to this extensive setup, which guarantees that it is ready for implementation and has the potential to transform agricultural practices while remaining dependable and effective.

4.1 Results Snapshots

4.1.1 Harvest Hive for Connection

Figure 4.1: Harvest hive for connection to registration page.

As shown in Figure 4.1, the platform's Harvest Hive acts as a portal to the registration page, where users can access and register for its services. Users may easily reach the registration page through Harvest Hive, where they can register and enjoy all of the features and functions, this agricultural technology platform has to offer. Because of this simplified connection, users may interact with the platform and start using its resources right away, ensuring a seamless onboarding experience. Serves as a link between users and the registration page, making the onboarding process easier. As the point of entry, Harvest Hive makes it easier for users to get started by directing them to the registration page, where they can register for the platform's services. This connection makes the agricultural technology platform more accessible and engaging while also guaranteeing a user-friendly experience.

4.1.2 Registration as Farmer

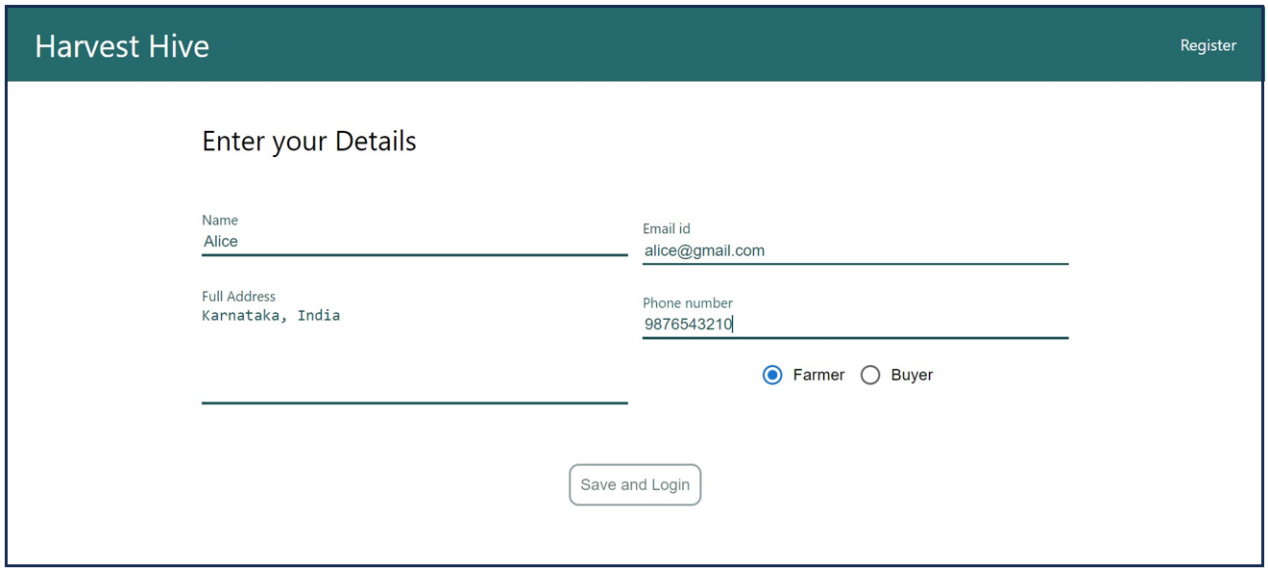

Figure 4.2: Registration page to register as farmer.

As shown in Figure 4.2, users can register as either buyers or farmers using the Registration Page. Users are required to enter basic information on this page, such as their name, complete address, phone number, email address, and whether they are a buyer or a farmer. The registration page gathers this data so that users can make customized profiles that correspond with their responsibilities in the agricultural ecosystem. Users may register and use the platform's features with ease thanks to this simplified approach, which is tailored to their individual needs and interests. The Registration Page serves as the portal for users to sign up as Buyers or Farmers on the site. The ability to indicate the user's position within the agricultural community. By obtaining this information, the registration process builds user-specific profiles that are customized to meet their needs, guaranteeing smooth access to the platform's features and encouraging a strong sense of community involvement.

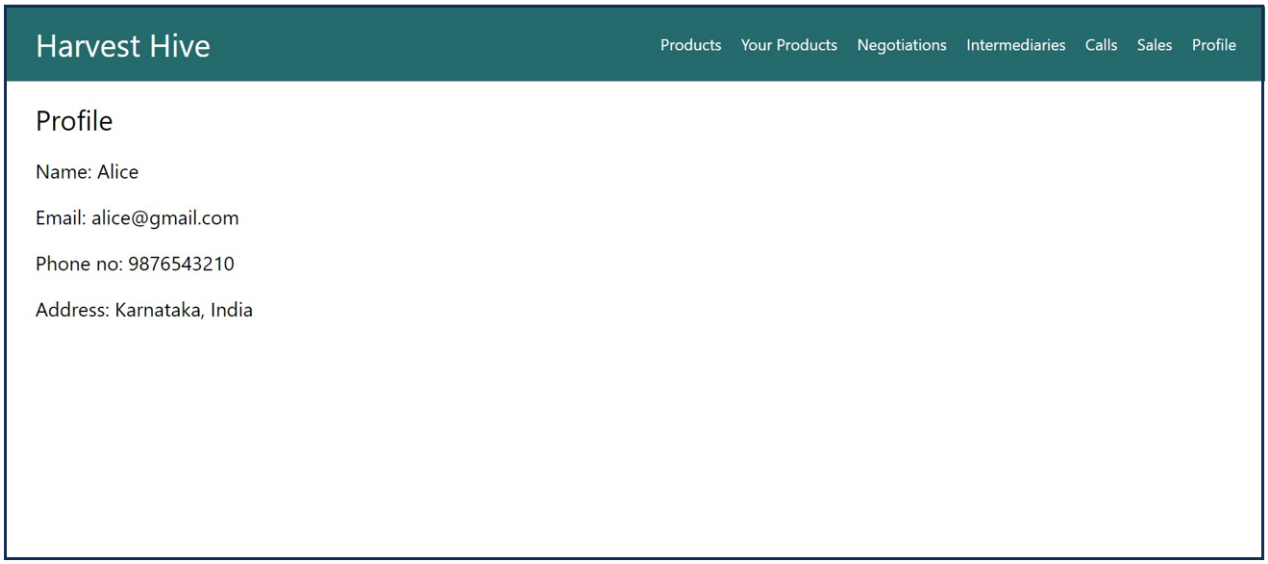

Figure 4.3: Profile of registered farmer.

As shown in Figure 4.3, featuring the name, complete address, phone number, and email address of registered farmers, the Farmer Profile offers an extensive presentation of their data. Through providing stakeholders with insightful information about specific farmers, this profile fosters collaboration and communication within the agricultural community. The Farmer Profile helps to build confidence and transparency between farmers and other parties involved in agricultural transactions by providing important contact information.

Figure 4.4: Farmer add the product by entering various details.

As shown in Figure 4.4, farmer can fill in the product addition form with different information for every product they want to add to their inventory. The product name, description, minimum, maximum, and total quantity offered are some of these details. The form helps farmers maintain their product listings efficiently by gathering this data, guaranteeing correct representation and open communication with prospective customers. This streamlined procedure improves agricultural transaction efficiency and makes it easier for farmers and buyers to communicate easily within the platform.

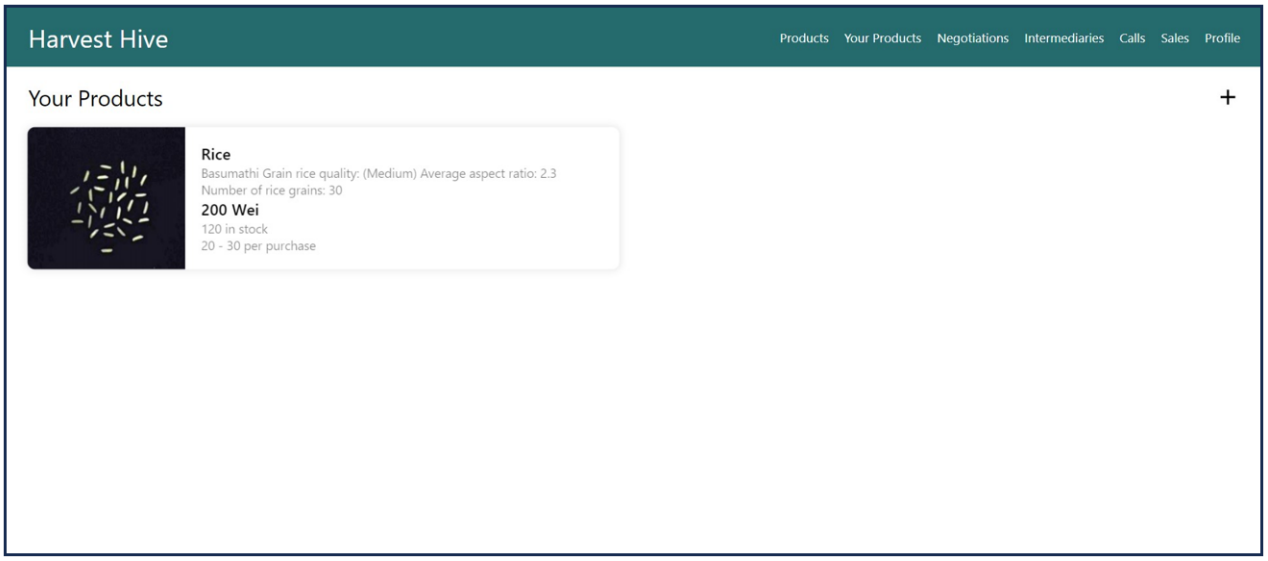

Figure 4.5: Products of the particular farmer in the platform.

As shown in Figure 4.5, the farmer's product listing gives users a thorough rundown of every product that a certain farmer on the network offers. Important information like the product name, description, quality features are all included in this listing. Users may quickly peruse the farmer's goods, evaluate the quality of the products, and make well-informed purchasing selections thanks to the presentation of this information. This feature improves openness and makes it easier for producers and buyers to deal smoothly in the agricultural market.

4.1.3 Registration as Buyer

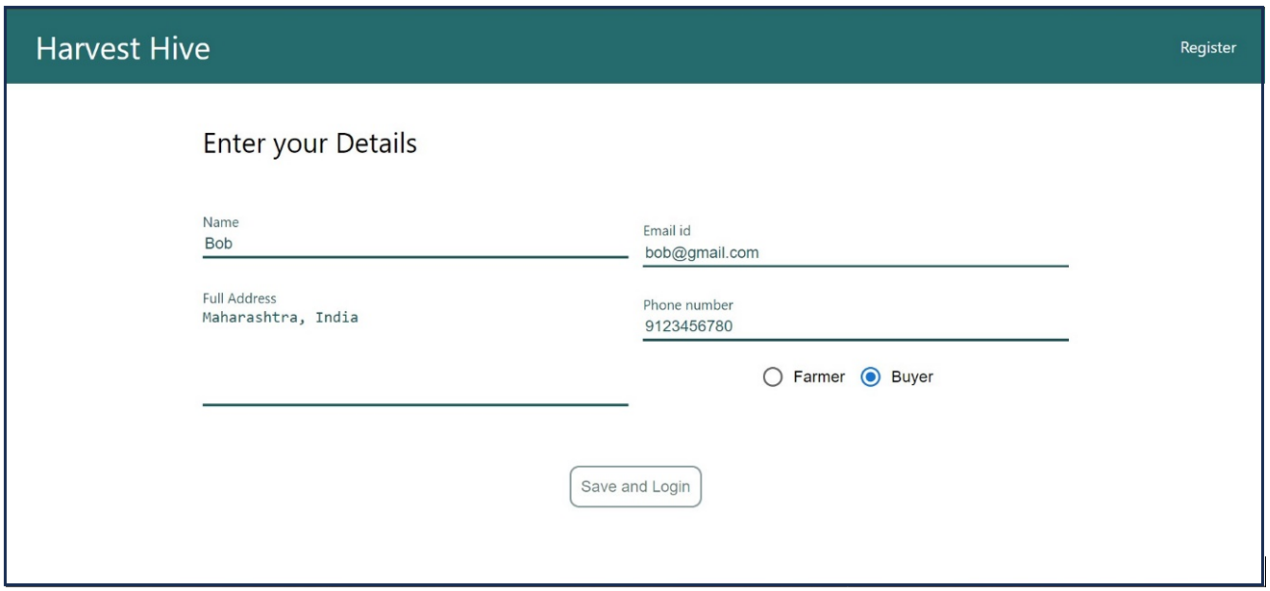

Figure 4.6: Registration page to register as buyer.

As shown in Figure 4.6, the buyer registration page acts as the entry point for users to sign up on the platform as buyers. Users are required to enter basic information on this page, including their name, complete address, phone number, email address, and whether they are a buyer or a farmer. The registration page gathers this data so that users can design profiles that are specific to their function as buyers in the agricultural community. Users may register and use the platform's features with ease thanks to this simplified approach, which is tailored to their individual needs and interests. This website allows purchasers to establish profiles that are specific to their function in the agricultural ecosystem, streamlining the registration process. The registration page gathers this information to guarantee that customers may quickly join the site and utilize its features, resulting in a smooth and easy onboarding process.

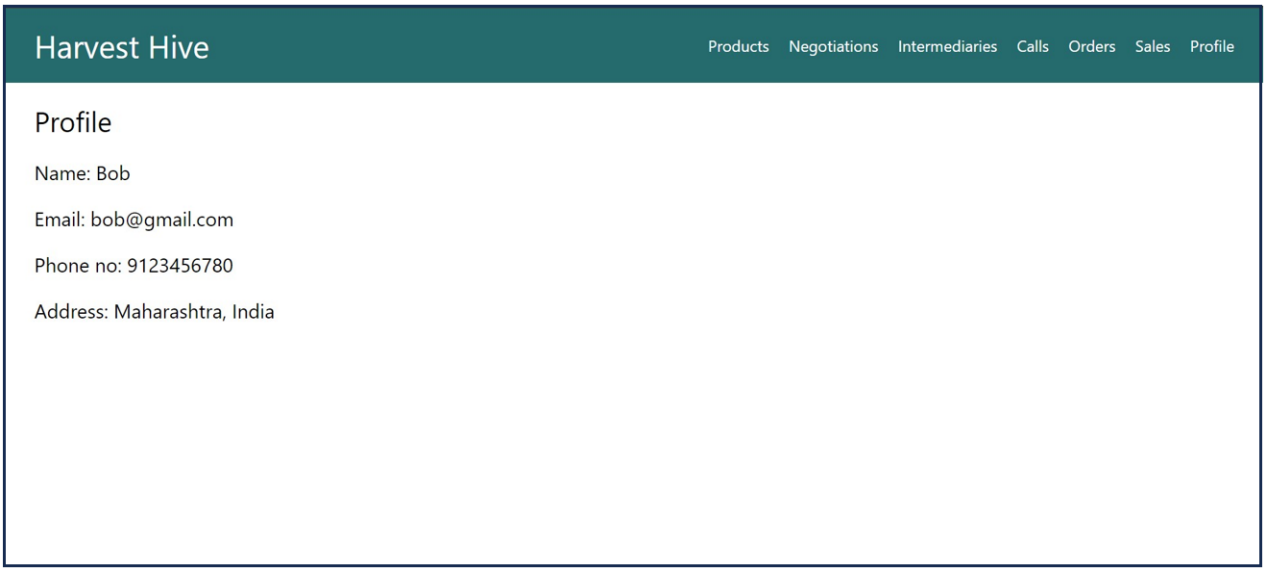

Figure 4.7: Profile of registered buyer.

As shown in Figure 4.7, the buyer profile displays the name, complete address, phone number, email address, and other information of registered purchasers. This extensive display facilitates communication and collaboration among the agricultural community by offering insightful information about individual buyers. The Buyer Profile encourages confidence and transparency between buyers and other parties involved in agricultural transactions by providing crucial contact information.

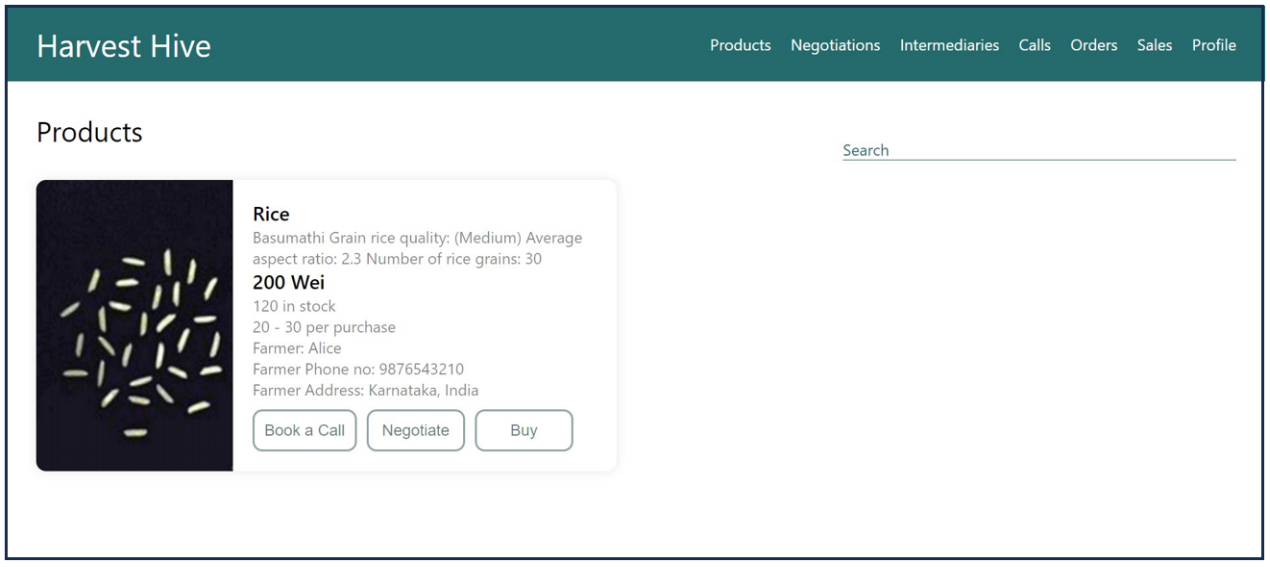

Figure 4.8: List of products that can be purchased by buyer.

As shown in Figure 4.8, the product catalog for Buyers lists all of the products that are for sale along with a variety of details. The product name, description, amount on hand, quality features, price, and any other pertinent information for that particular product are usually included in these data. Through the provision of this thorough synopsis, the product catalog enables purchasers to make well-informed choices, so promoting smooth transactions and building confidence in the agriculture industry.

4.1.4 Negotiation

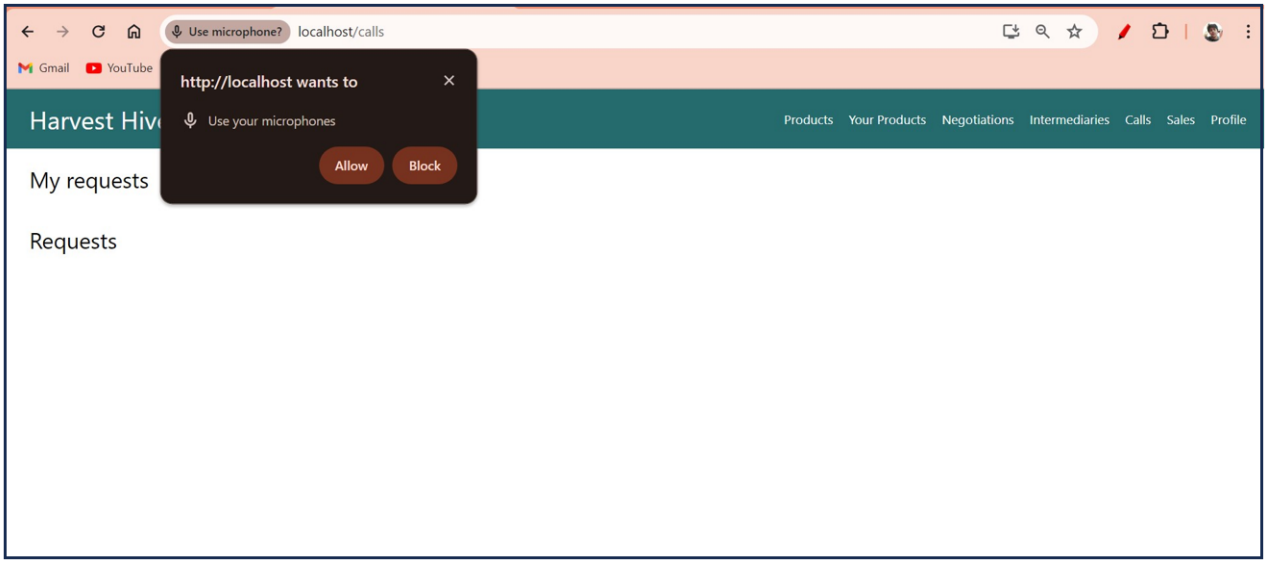

Figure 4.9: Asking permission of microphone usage for call between farmer and buyer.

As shown in Figure 4.9, the order to facilitate negotiations, the portal asks the user to allow microphone use before connecting a farmer and a buyer. This guarantees that during the negotiating process, both parties can communicate efficiently. The technology facilitates smooth voice contact between farmers and buyers by granting microphone access, which enables them to negotiate terms and settle on a price. This feature improves the negotiating process by encouraging fruitful conversations and promoting understanding between agricultural community stakeholders.

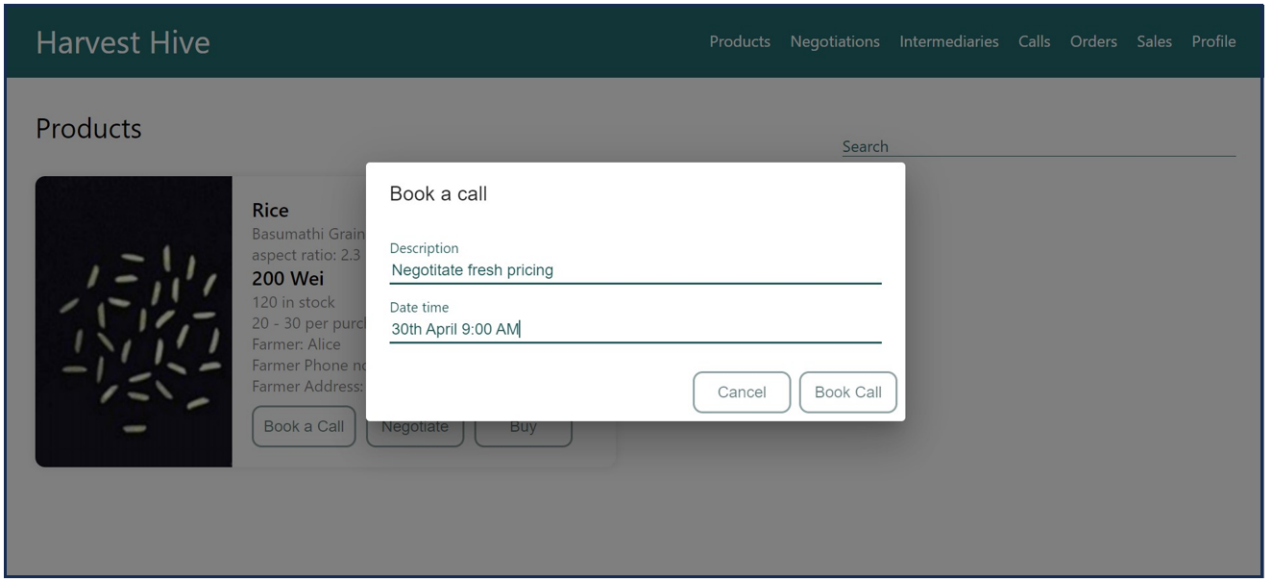

Figure 4.10: Window to book a call from buyer to farmer.

As shown in Figure 4.10, the call booking window gives purchasers a way to arrange phone conversations with farmers in order to start talks. With the use of this feature, purchasers can request a call for negotiation from the farmer at a convenient moment. The call booking window expedites the negotiation process by permitting communication between buyers and farmers. This leads to fruitful discussions and mutually beneficial agreements on terms and pricing.

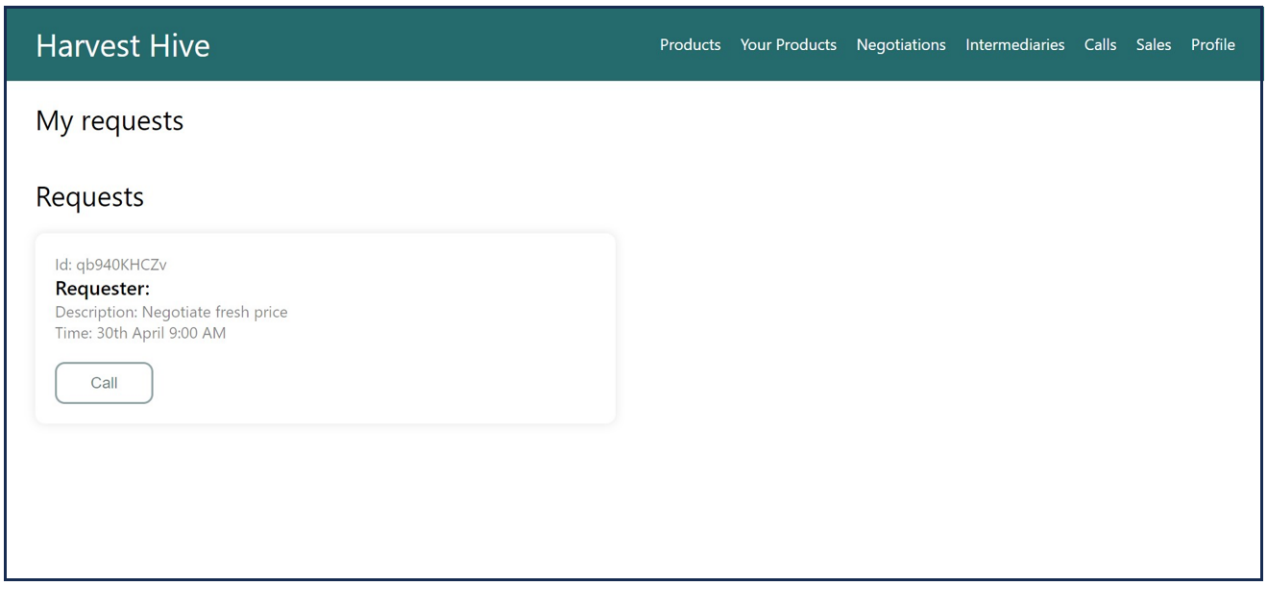

Figure 4.11: Negotiation request by buyer to farmer.

As shown in Figure 4.11, Buyers can use the negotiation request window to phone farmers and request negotiations. With the use of this function, customers can contact farmers to indicate their interest in settling on conditions and prices for particular items. The negotiation request window expedites the negotiation process by enabling communication between buyers and farmers, promoting open and fruitful dialogue to arrive at win-win agreements.

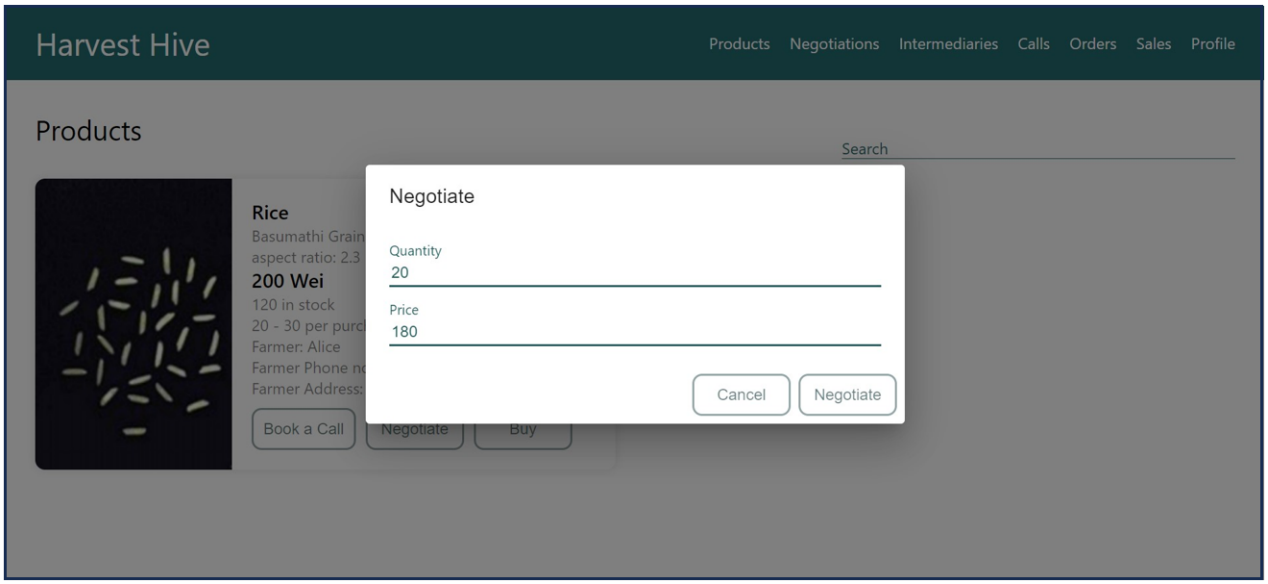

Figure 4.12: Negotiation requesting by buyer for minimum amount.

As shown in Figure 4.12 buyers can start a negotiation with farmers by suggesting a minimum amount for a product or group of items using the minimum amount negotiation request feature. By using this tool, buyers may let farmers know what their intended minimum price is, starting a dialogue that aims to find a solution that works for all parties. By streamlining the negotiating process, this feature helps buyers and farmers to communicate openly and constructively in order to agree on reasonable pricing arrangements.

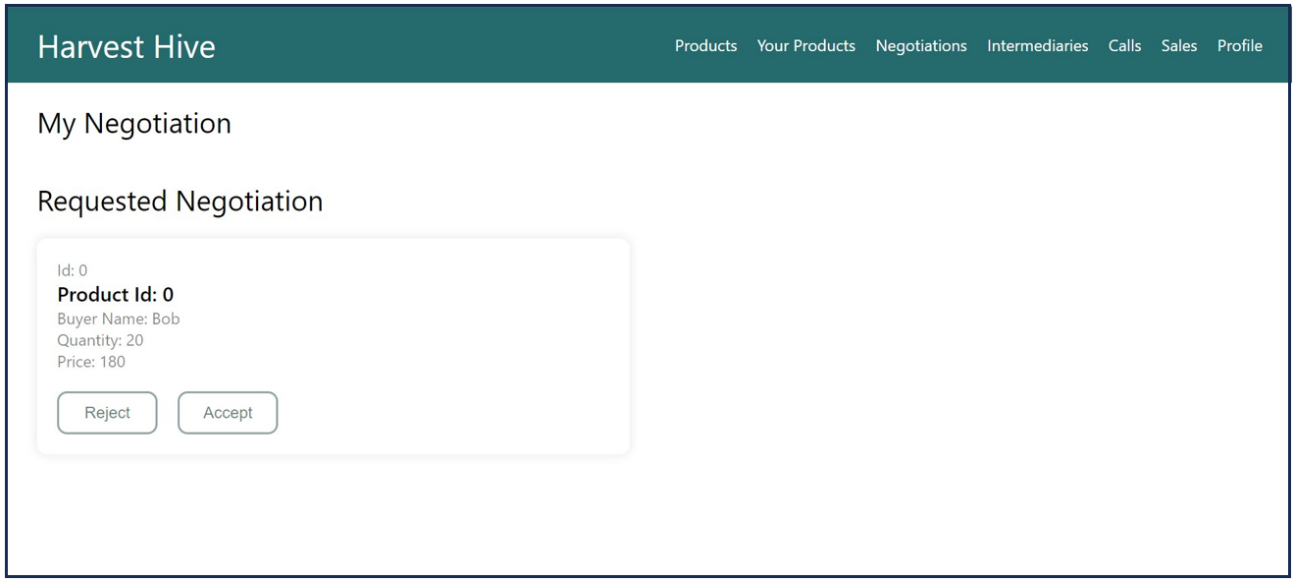

Figure 4.13: Negotiation requesting for farmer to either accept or reject the request.

As shown in Figure 4.13 farmers can examine and reply to negotiation requests made by purchasers by using the farmer negotiation request handling tool. Farmers can choose to accept or reject the buyer's request for negotiations by using this functionality. This capacity enables farmers to make well-informed decisions about conditions and prices, promoting open dialogue and mutually advantageous agreements between producers and buyers in the agricultural market.

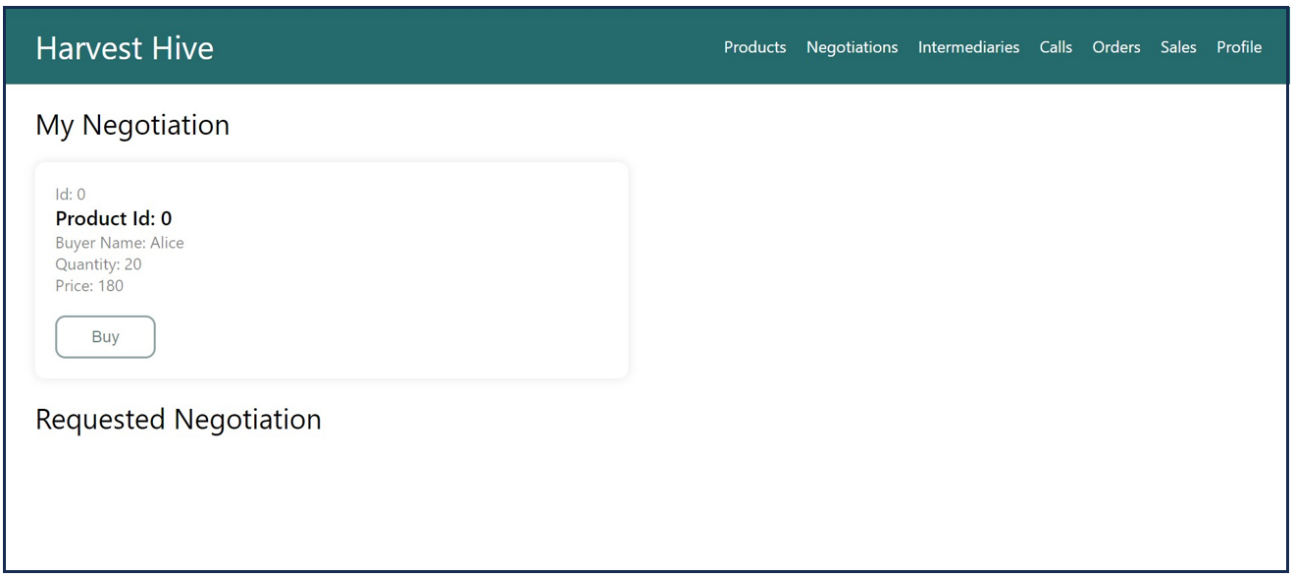

Figure 4.14: Farmer accepted the request, buyer can now buy the product.

As shown in Figure 4.14, the buyer can buy the produce through their window once the farmer grants their request for bargaining. With a simplified procedure, both sides may complete the transaction without any problems, and the customer can purchase the product straight from their interface. By making this feature available, this platform helps farmers and buyers interact in an efficient and transparent manner, improving the user experience in the agricultural marketplace as a whole.

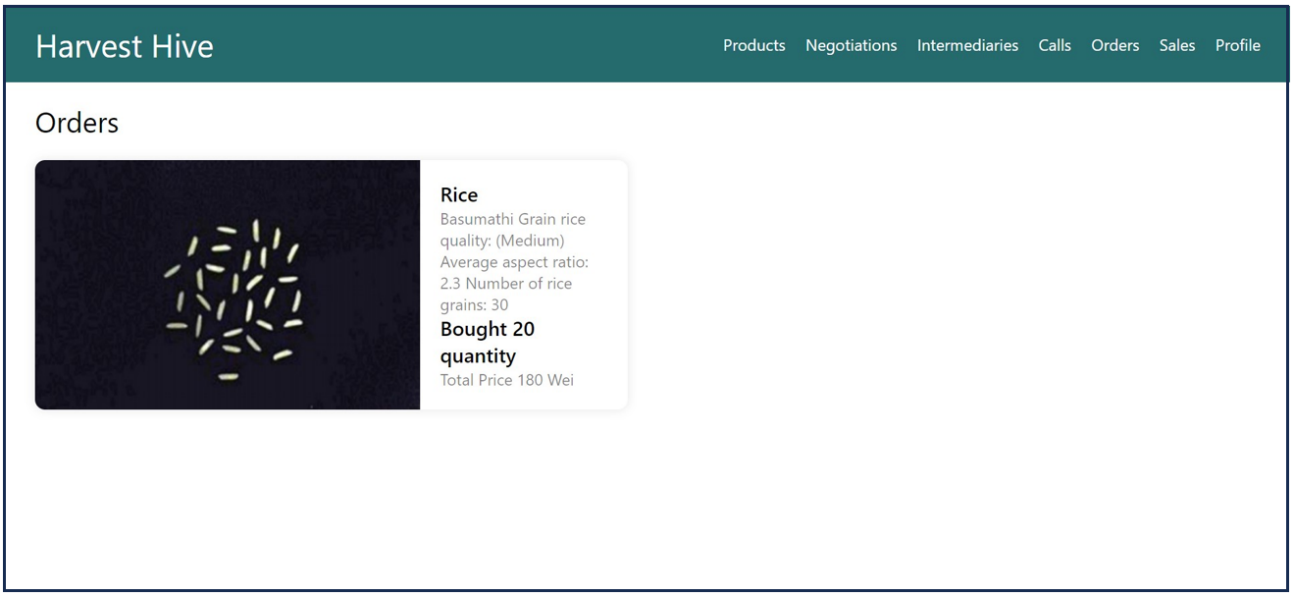

Figure 4.15: List of product ordered by particular buyer.

As shown in Figure 4.15, A record of the products that a specific customer has ordered is shown in the Orders section. With information on product names, quantities, prices, and order dates included, this feature offers a thorough summary of previous purchases. By providing this data, purchasers may effortlessly keep tabs on their past purchases, examine past exchanges, and observe their interactions on the platform. This feature improves the user experience and encourages openness in the transactions made by buyers in the agriculture market.

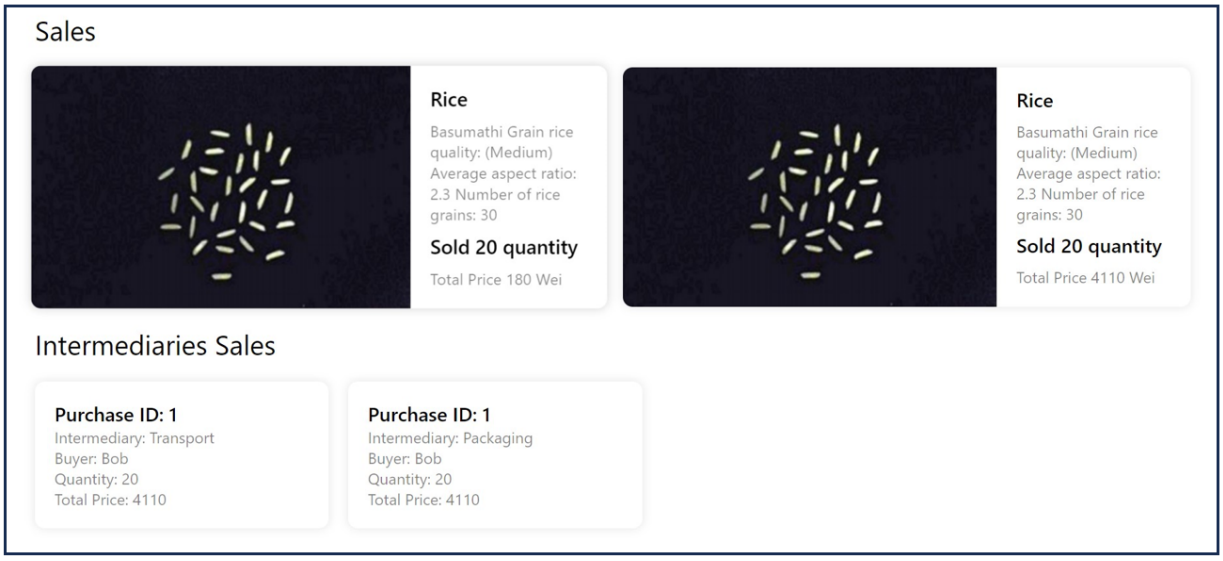

Figure 4.16: List of products sold by particular farmer.

As shown in Figure 4.16, A list of goods sold by a specific farmer is shown in the Sales section. A thorough summary of previous sales is provided by this function, together with information on product names, quantities, prices, and transaction dates. Farmers can track their sales history, evaluate their performance, and keep an eye on their interactions inside the platform by supplying this information. This feature makes using the agricultural marketplace more pleasant for users and encourages farmers to interact in a transparent manner.

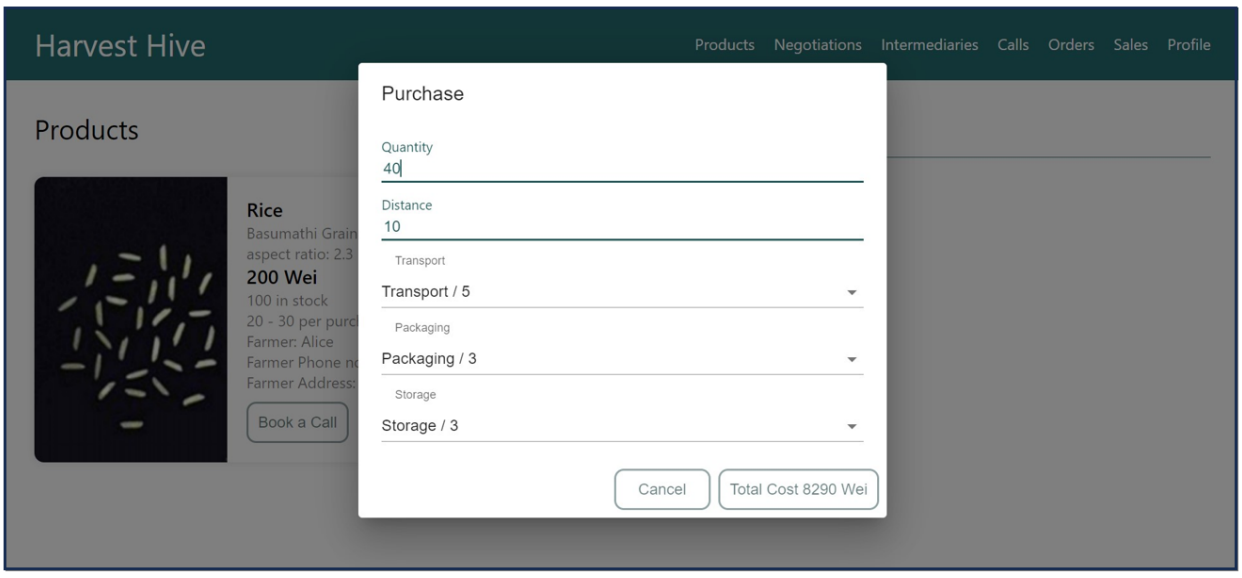

Figure 4.17: Product purchase by buyer with the service of intermediary.

As shown in Figure 4.17, when a buyer uses an intermediary to purchase a product, the intermediary offers extra services including transportation, storage, and packaging. With the help of this comprehensive service, you can be sure that the goods you've bought are handled, stored, and delivered from the farmer to you safely and effectively. The intermediary improves the entire transaction experience by delivering these value-added services, which streamline logistics and provide the buyer and the farmer peace of mind.

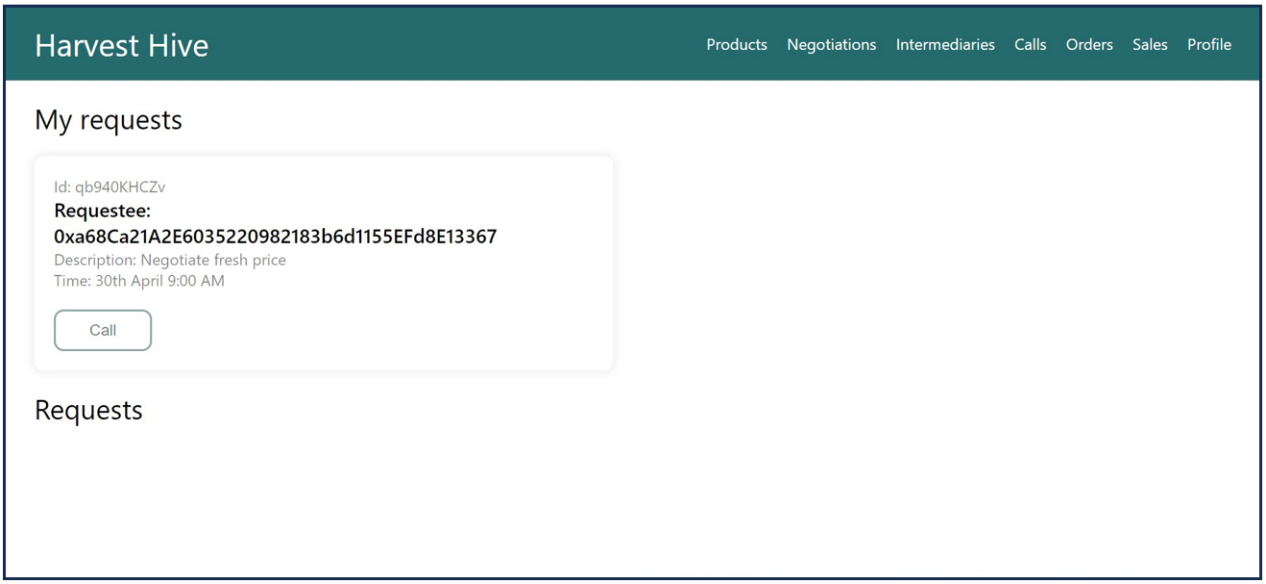

Figure 4.18: List of upcoming negotiation request at buyer end.

As shown in Figure 4.18, A list of negotiation requests that are either pending or scheduled at the buyer's end is shown in the upcoming negotiation requests section. Buyers can analyze upcoming negotiation possibilities using this tool, which includes information on the commodity under negotiation, the farmer involved, and the negotiation's scheduled time. By giving purchasers access to this data, they can plan and get ready for future talks and make sure that farmers are contacted promptly and effectively in order to come to mutually advantageous agreements. This feature improves openness and makes fruitful discussions easier in the agriculture market.

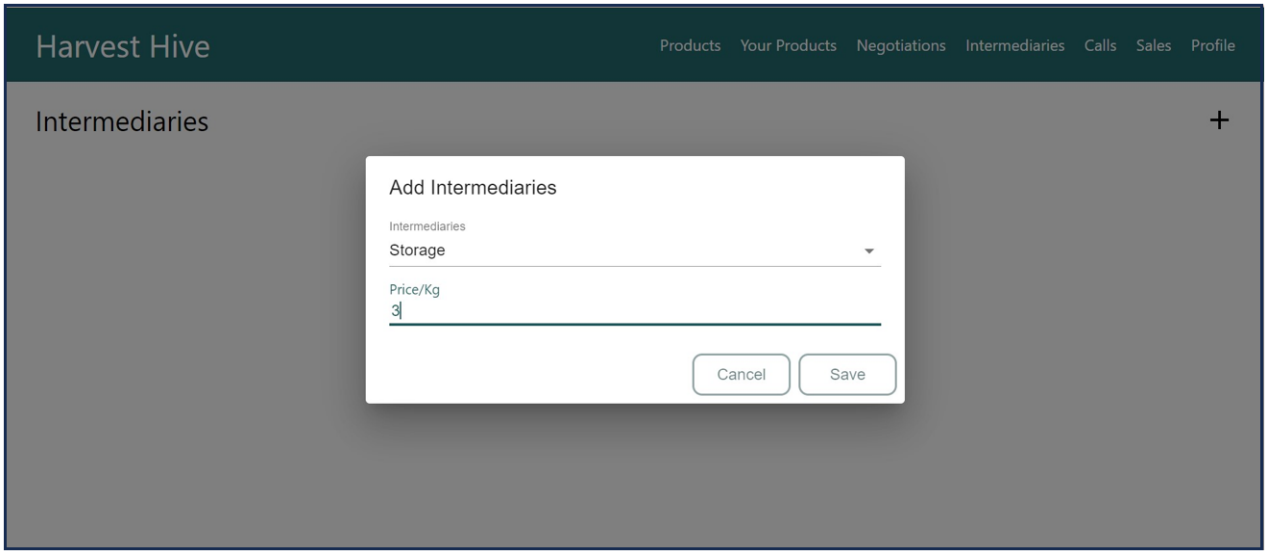

Figure 4.19: Intermediary registration to the platform.

As shown in Figure 4.19, the intermediary registration form allows intermediaries to register on the platform by giving information about the services they provide, such as packaging, transportation, storage, and the associated cost per kilogram. Important data such the intermediary's name, contact information, service offerings, price schedule, and any extra terms and conditions are gathered in this form. Intermediaries can utilize the platform's services, connect with farmers and buyers, and ease transactions within the agricultural industry by completing this registration process.

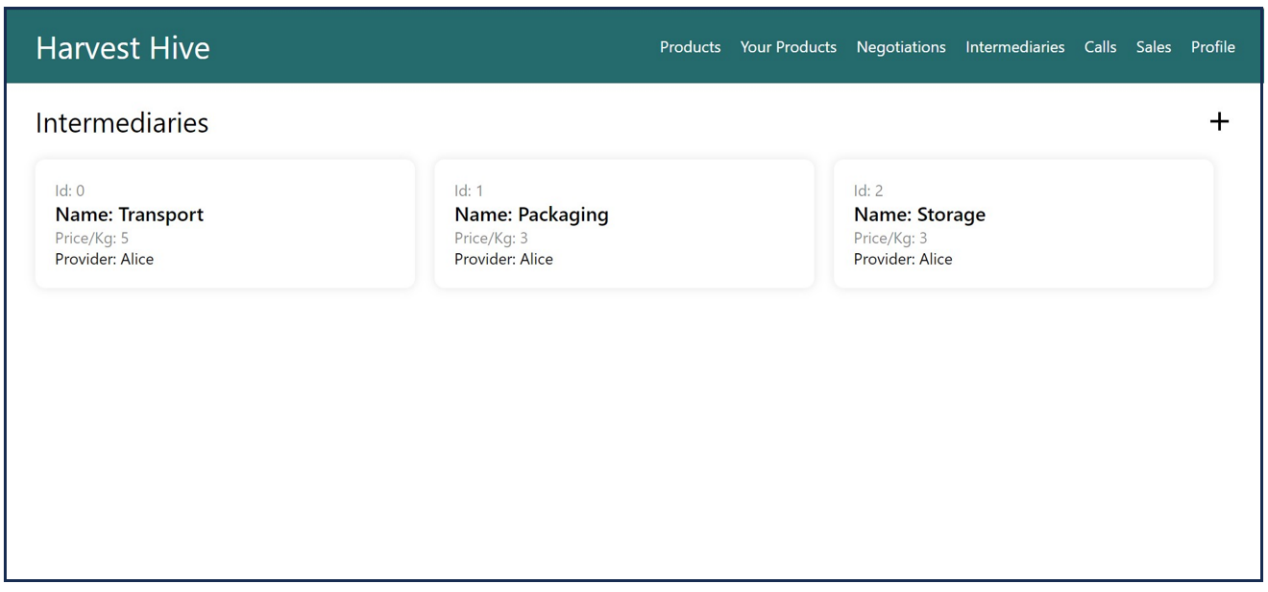

Figure 4.20: List of intermediaries registered to the platform.

As shown in Figure 4.20, an extensive list of intermediates who have registered with the platform is available in the intermediary directory. The intermediary's name, contact information, and the services they provide storage, transportation, packaging, and cost per kilogram are all listed in this database. By providing this data, intermediaries are made easily accessible to users, enabling seamless and effective transactions within the agricultural market. This tool helps buyers, farmers, and middlemen work together more effectively and transparently, which eventually benefits all parties.

4.2 Testing

i **Unit Testing:** Unit testing involves testing individual components to ensure their proper functionality. Examples of unit tests include verifying blockchain transaction processing, validating traceability of agricultural products, testing smart contract execution, assessing data management capabilities, validating integration with external systems, ensuring security measures, handling errors gracefully, assessing performance, and evaluating usability. These tests aim to ensure the reliability, security, and functionality of the agricultural blockchain system.

• **Blockchain Transaction Processing:** Verify that the blockchain transaction processing component can accurately handle transactions related to agricultural product tracking, smart contract execution, and data management.

• **Traceability Verification:** Test the system's ability to trace agricultural products through the supply chain by providing various input scenarios and ensuring that the system accurately tracks the product's origin, quality, and movement.

• **Smart Contract Execution:** Validate the functionality of smart contracts within the agricultural blockchain system by providing different input scenarios and verifying that the contracts execute transactions securely and efficiently.

• **Data Management:** Test the system's data management capabilities by ensuring that it can store, retrieve, and update agricultural data securely and reliably on the blockchain.

• **Integration Testing with External Systems:** Validate the integration of the agricultural blockchain system with external systems, such as IoT devices, agricultural databases, or supply chain management systems. Ensure seamless data exchange and interoperability between the blockchain system and these external

components.

• **Security Testing:** Test the system's security mechanisms, including encryption, authentication, and access control, to ensure protection against unauthorized access, data tampering, and cyber threats.

• **Error Handling:** Test the system's behavior in error scenarios, such as when invalid transactions are attempted or when unexpected errors occur during transaction processing. Verify that the system handles such situations gracefully and provides appropriate error messages or fallback options.

• **Performance Testing:** Assess the performance of the agricultural blockchain system by measuring factors such as transaction processing speed, network latency, and resource utilization. Evaluate how the system performs under varying workload conditions and ensure scalability to accommodate growing demands within the agricultural supply chain.

• **Usability Testing:** Evaluate the usability and user experience of the agricultural blockchain system by assessing factors such as clarity of information presented, ease of use, and navigation within the system. Ensure that the system is intuitive and user-friendly for stakeholders involved in agricultural operations.

ii **Integration Testing:** Integration testing involves validating the interaction and integration between different components and systems within the agricultural blockchain ecosystem. This includes testing the integration between the blockchain platform, IoT devices, external systems, smart contracts, user interfaces, and security mechanisms. The testing ensures seamless communication, data exchange, and interoperability between these components to achieve the project's objectives of enhancing traceability, transparency, and efficiency in agricultural operations.

• **Blockchain Integration:** Test the integration between the blockchain platform and other components of the agricultural system, such as smart contracts, data management modules, and user interfaces. Ensure seamless communication and data exchange between the blockchain and other system components.

• **IoT Device Integration:** Validate the integration between IoT devices, sensors, and the blockchain-based agricultural system. Test data collection, transmission, and processing capabilities to ensure that agricultural data from IoT devices are

accurately captured and stored on the blockchain.

• **External System Integration:** Test integration with external systems, such as agricultural databases, supply chain management systems, or regulatory compliance platforms. Ensure interoperability and smooth data exchange between the blockchain system and these external systems.

• **Smart Contract Integration:** Verify the integration between smart contracts and other components of the agricultural blockchain system. Test the execution of smart contracts, data validation, and enforcement of business rules to ensure consistency and reliability in transaction processing.

• **User Interface Integration:** Test the integration between the user interface or frontend applications and the backend blockchain system. Ensure that user inputs are properly processed, transactions are executed securely, and relevant information is displayed to stakeholders.

• **Data Exchange Validation:** Validate data exchange mechanisms between different entities within the agricultural supply chain, such as farmers, distributors, retailers, and consumers. Test the accuracy and integrity of data transferred between these entities via the blockchain system.

• **Security and Access Control Integration:** Test integration with security mechanisms, access control policies, and encryption protocols to ensure data security and confidentiality within the agricultural blockchain ecosystem. Validate that only authorized users have access to sensitive information and transactions.

• **Regulatory Compliance Integration:** Validate integration with regulatory compliance frameworks and standards relevant to the agricultural sector. Ensure that the blockchain system complies with data protection laws, food safety regulations, and industry standards governing agricultural operations.

4.2.1 Test Case Details

i **Test Case 1**

ID: 1. Unit to test: Traceability of a specific agricultural product.

Expected output: Successfully track and display detailed information about the origin, quality etc. of the agricultural product within the blockchain system.

Pass or Fail: Pass

ii **Test Case 2**

ID: 2. Unit to test: Execution of a smart contract for crop sale.

Expected output: Smart contract accurately executes the transaction, transferring ownership of the crop from the farmer to the buyer, and recording the transaction details on the blockchain ledger.

Pass or Fail: Pass

iii **Test Case 3**

ID: 3. Unit to test: Data exchange between different stakeholders in the agricultural supply chain.

Expected output: Seamless exchange of data between farmers, Legitimate Intermediaries and consumers, ensuring transparency and traceability throughout the supply chain.

Pass or Fail: Pass

iv **Test Case 4**

ID: 4. Unit to test: Data management for supply chain transparency.

Expected output: The system effectively manages and updates supply chain data on the blockchain, ensuring transparency and traceability.

Pass or Fail: Pass

v **Test Case 5**

ID: 5. Unit to test: Performance under peak load conditions.

Expected output: The system maintains optimal performance, throughput, and scalability even under peak workload conditions.

Pass or Fail: Pass

vi **Test Case 6**

ID: 6. Unit to test: Usability and user experience of the system interface.

Expected output: The system interface is intuitive, user-friendly, and provides stakeholders with clear and accessible information.

Pass or Fail: Pass

vii **Test Case 7**

ID: 7. Unit to test: Accuracy of rice quality analysis.

Expected output: With a high degree of precision, the rice quality analysis classifies rice grains according to their length, breadth, and length-breadth ratio.

Pass or Fail: Pass

viii **Test Case 8**

ID: 8. Unit to test: Security of user data and transactions.

Expected output: Confidentiality and integrity are guaranteed for user data and transactions, which are safely encrypted and shielded from unwanted access or manipulation.

Pass or Fail: Pass

ix **Test Case 9**

ID: 9. Unit to test: Compatibility with various devices and browsers.

Expected output: The system offers a uniform user experience and functionality across various devices and browsers.

Pass or Fail: Pass

Chapter 5

Conclusion

This project represents a beacon of innovation in the agricultural sector, advocating transparency and fairness as its guiding principles. It transcends mere transactional efficiency to redefine the narrative of agriculture. Through the integration of blockchain technology and smart contracts, this initiative establishes a decentralized and secure framework, fostering trust among stakeholders. The user-friendly interface ensures seamless interactions, bridging participants and the decentralized system, facilitating efficient access to blockchain data. Beyond its technological courageousness, this project embodies a commitment to empower farmers and nurture resilient communities. It surpasses conventional success metrics to promise a deep and enduring impact on the agricultural sector. It envisions a future where transparency and fairness are not just aspirations but the cornerstones of progress.

At its essence, this project seeks to empower farmers with fair pricing, ensure transparency in agricultural transactions, expand market access for farmers, and facilitate the integration of legitimate intermediaries. This initiative heralds a profound cultural shift in the agricultural industry, rooted in the principles of justice and openness. It aims to revolutionize agriculture by simplifying connections between stakeholders, ensuring accessibility, and fostering confidence. This steadfast commitment to robust data management and farmer empowerment represents a beacon of hope for building resilient communities. It embodies a commitment to lasting and positive change in agriculture, where justice and openness illuminate the path to a brighter future for all.

5.1 Scope for future work

This project has a great deal of room to grow and evolve as it consider the accomplishments and look to the future. In future, the hope to improve the platform's usability and functionality to better meet the changing demands and preferences of agricultural stakeholders. To give farmers and other supply chain participants useful insights, this may entail incorporating advanced analytics. Furthermore, investigating ways to include cutting-edge technologies, that support systems to improve the effectiveness and robustness of farming operations.

This project has a great deal of room to expand and develop going forward, building on its accomplishments to date and looking to the future. Future improvements to the platform's usability and functionality are highly desired in order to better meet the changing needs and preferences of agricultural stakeholders. In order to give farmers and other supply chain players useful insights and prediction skills, this may include integrating machine learning algorithms.

Additionally, investigating ways to integrate state-of-the-art technologies will be crucial to enhancing farming operations' resilience and efficacy. Through the use of these technologies, the initiative hopes to improve agricultural output, maximize resource use, and stimulate innovation. In general, the project's future scope is concentrated on innovation and ongoing improvement to make sure it stays at the forefront of solving the opportunities and challenges in the agriculture industry.

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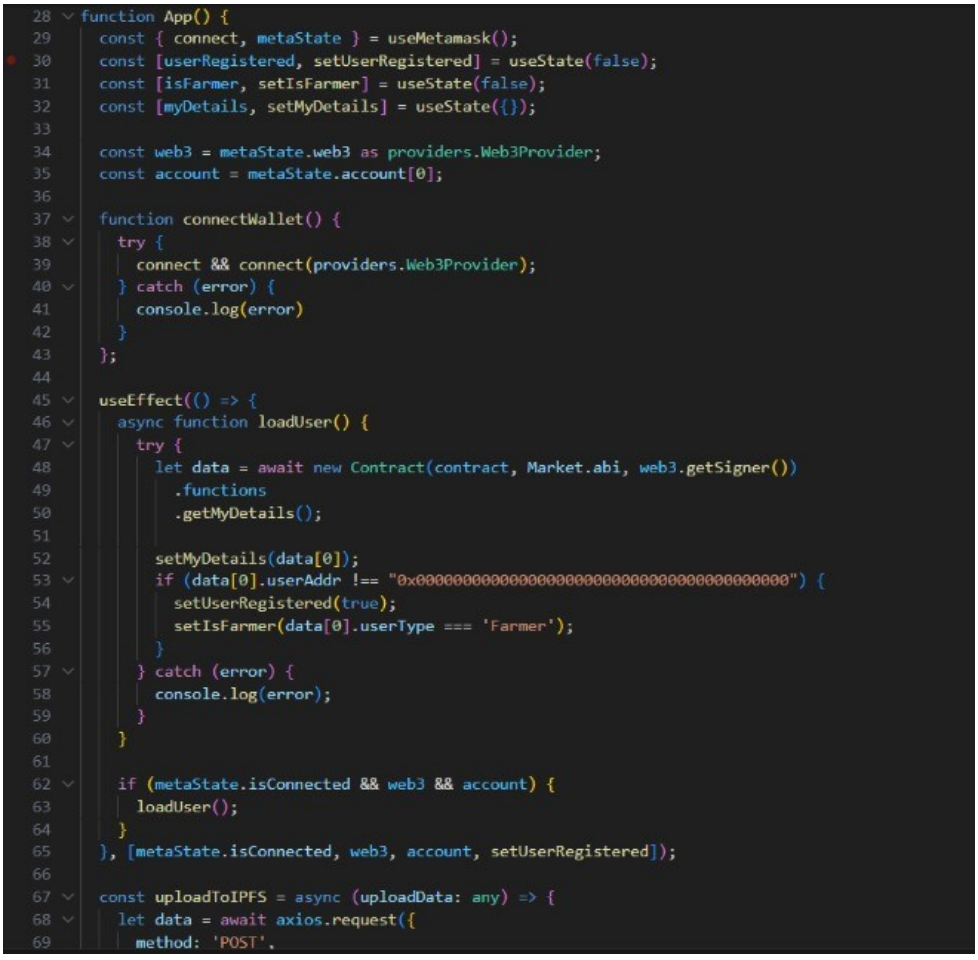
Appendices

Appendix A

Code Snippets

A.1 Code Snippet - Main Module



```
function App() {
  const { connect, metaState } = useMetamask();
  const [userRegistered, setUserRegistered] = useState(false);
  const [isFarmer, setIsFarmer] = useState(false);
  const [myDetails, setMyDetails] = useState({});

  const web3 = metaState.web3 as providers.Web3Provider;
  const account = metaState.account[0];

  function connectWallet() {
    try {
      connect && connect(providers.Web3Provider);
    } catch (error) {
      console.log(error)
    }
  };

  useEffect(() => {
    async function loadUser() {
      try {
        let data = await new Contract(contract, Market.abi, web3.getSigner())
          .functions
          .getMyDetails();

        setMyDetails(data[0]);
        if (data[0].userAddr !== "0x0000000000000000000000000000000000000000") {
          setUserRegistered(true);
          setIsFarmer(data[0].userType === 'Farmer');
        }
      } catch (error) {
        console.log(error);
      }
    }

    if (metaState.isConnected && web3 && account) {
      loadUser();
    }
  }, [metaState.isConnected, web3, account, setUserRegistered]);

  const uploadToIPFS = async (uploadData: any) => {
    let data = await axios.request({
      method: 'POST',
```

Figure A.1: Main module code for making routing decision in the interface.

The snippet A.1 represents the Main Module, which acts as the pivotal entry point for users navigating in agricultural technology platform. It serves as the central hub where users make routing decisions, selecting from various options to access different sections and functionalities within the interface. By providing clear navigation pathways and empowering users to initiate actions according to their needs, the “Main module” plays a crucial role in facilitating intuitive and efficient user interactions with this platform.

A.2 Code Snippet - Rice Quality Analysis Module

```python
def get_classification(ratio):
    ratio = round(ratio, 1)
    to_return = ""
    if ratio >= 3:
        to_return = "Slender"
    elif 2.1 <= ratio < 3:
        to_return = "Medium"
    elif 1.1 <= ratio < 2.1:
        to_return = "Bold"
    elif ratio <= 1:
        to_return = "Round"
    return "(" + to_return + ")"


@app.route('/classify', methods=['POST'])
def classify_image():
    image_data = request.files['image']

    if image_data:
        nparr = np.frombuffer(image_data.read(), np.uint8)
        img = cv2.imdecode(nparr, cv2.IMREAD_GRAYSCALE)
        print("called")

        ret, binary = cv2.threshold(img, 160, 255, cv2.THRESH_BINARY)

        kernel = np.ones((5, 5), np.float32)/9
        dst = cv2.filter2D(binary, -1, kernel)

        kernel2 = cv2.getStructuringElement(cv2.MORPH_ELLIPSE, (3, 3))

        erosion = cv2.erode(dst, kernel2, iterations=1)

        contours, _ = cv2.findContours(
            erosion, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)

        total_ar = 0
        aspect_ratios = []
        for cnt in contours:
            x, y, w, h = cv2.boundingRect(cnt)
            aspect_ratio = float(w) / h
            if aspect_ratio < 1:
                aspect_ratio = 1 / aspect_ratio
```

Figure A.2: Rice quality analysis module code for classifying rice grain based on quality.

The snippet A.2 represents the Rice Quality Analysis Module, which is a key component designed to assess the quality of rice grains. By analyzing key parameters such as length, breadth, and length-to-breadth ratio, this module classifies rice grains into categories such as Slender, Medium, Bold, or Round. The module accurately evaluates grain characteristics to provide valuable insights for farmers and buyers.

A.3 Code Snippet - Farmer Module

```
export default function AddProduct(props: AddProductProps) {
    const [productImageContent, setProductImageContent] = React.useState<null>(null);
    const [productImage, setProductImage] = React.useState<string | null>(null);
    const [productName, setProductName] = React.useState<string>('');
    const [productDescription, setProductDescription] = React.useState<string>('');
    const [productPrice, setProductPrice] = React.useState<number>(0);
    const [productMinQuantity, setProductMinQuantity] = React.useState<number>(0);
    const [productMaxQuantity, setProductMaxQuantity] = React.useState<number>(0);
    const [productTotalQuantity, setProductTotalQuantity] = React.useState<number>(0);
    const [productQuality, setProductQuality] = React.useState<string>('');

    const navigate = useNavigate();

    useEffect(() => {
        const fetchData = async () => {
            if (productImage === null || productImageContent ===null) return;
            try {
                const formData = new FormData();
                formData.append('image', productImageContent);

                const response = await axios.post("http://localhost:5000/classify", formData, {
                    headers: {
                        'Content-Type': 'multipart/form-data',
                    }
                });
                const data = response.data;
                if (data['error'] !== undefined) {
                    setProductQuality("Error: " + data['error']);
                    return;
                }
                setProductQuality("Grain rice quality: " + data['classification'] + "\n" +
                    "Average aspect ratio: " + data['average_aspect_ratio'] + "\n" +
                    "Number of rice grains: " + data['no_of_rice_grains']);
            } catch (error) {
                console.log(error)
            }
        };
        setProductQuality("");
        fetchData();
    }, [productImage]);
```

Figure A.3: Farmer module code for adding various details of the product.

The snippet A.3 represents the Farmer Module, which serves as a dedicated platform for farmers to input and manage information about their agricultural products. Within this module, farmers can easily add details such as crop type, quantity, quality attributes, and cultivation practices associated with each specific product they have grown. By providing a user-friendly interface, this module empowers farmers to effectively document and track important details related to their produce. This streamlined process facilitates better management of farm inventory, enhances traceability, and ultimately supports informed decision-making for both farmers and stakeholders.

A.4 Code Snippet - Buyer Module

```
export default function Products(props: ProductsProps) {
    const [dialogOpen, setDialogOpen] = React.useState(false);
    const [negotiateDialogOpen, setNegotiateDialogOpen] = React.useState(false);
    const [callDialogOpen, setCallDialogOpen] = React.useState(false);
    const [selectedProduct, setSelectedProduct] = React.useState<Product | null>(null);
    const [description, setDescription] = React.useState('');
    const [datetime, setDatetime] = React.useState('');
    const [quantity, setQuantity] = React.useState(0);
    const [price, setPrice] = React.useState(0);
    const [distance, setDistance] = React.useState(10);
    const [products, setProducts] = React.useState<Product[]>([]);
    const [accessories, setAccessories] = React.useState<Accessory[]>([]);
    const [accessoryId1, setAccessoryId1] = React.useState(-1);
    const [accessoryId2, setAccessoryId2] = React.useState(-1);
    const [accessoryId3, setAccessoryId3] = React.useState(-1);
    const [searchName, setSearchName] = React.useState('');
    const [ownerAddress, setOwnerAddress] = React.useState('');

    useEffect(() => {
        async function getData() {
            const products = await props.getProducts(props.account);

            let productProcessed: Product[] = [];
            for (let i = 0; i < products.length; i++) {
                // @ts-ignore
                const data = await axios.get(props.getFileFromIPFS(products[i].productImage));
                var blobUrl = URL.createObjectURL(new Blob([Buffer.from(data.data.image.data, "utf-8")]));

                // @ts-ignore
                if (BigNumber.from(products[i].totalQuantity).toNumber() === 0) continue;
                // @ts-ignore
                const userDetails = await props.getUser(props.account, products[i].ownerAddress);

                productProcessed.push({
                    // @ts-ignore
                    ...products[i],
                    // @ts-ignore
                    ...userDetails[0],
                    // @ts-ignore
                    productId: BigNumber.from(products[i].productId).toNumber(),
                    // @ts-ignore
```

Figure A.4: Buyer module code for select the product to order.

The snippet A.4 represents the Buyer Module, which offers buyers a straightforward interface to browse and select products they wish to purchase from a list provided by farmers. Through this module, buyers can easily navigate available products, view relevant details such as type, quantity, and quality and select items for purchase. By streamlining the ordering process, this module facilitates efficient communication between buyers and farmers, enabling seamless transactions and promoting transparency in the agricultural marketplace.

A.5 Code Snippet - Negotiation Module

```
export default function Calls(props: CallProps) {
    const [dialogOpen, setDialogOpen] = React.useState(false);
    const [roomId, setRoomId] = React.useState('');
    const [callDetails, setCallDetails] = React.useState<CallDetails[]>([]);
    const [myCallDetails, setMyCallDetails] = React.useState<CallDetails[]>([]);
    const [socket, setSocket] = React.useState(null);
    const [data, setData] = React.useState([]);
    const [audioContext, setAudioContext] = React.useState(null);

    useEffect(() => {
        const newSocket = io('http://localhost:5000');
        newSocket.on('connect', () => { });
        // @ts-ignore
        setSocket(newSocket);
        return () => {
            newSocket.close();
        };
    }, [setSocket]);

    useEffect(() => {
        if (!socket) return;
        navigator.mediaDevices
            .getUserMedia({
                audio: true,
                video: false,
            }).then((stream) => {
                const audioContext = new AudioContext();
                let input = audioContext.createMediaStreamSource(stream);
                let processor = input.context.createScriptProcessor(16384, 1, 1);
                processor.onaudioprocess = function (e) {
                    let floatArray = e.inputBuffer.getChannelData(0);
                    // @ts-ignore
                    setData((oldData) => [...oldData, ...floatArray]);
                }

                input.connect(processor);
                processor.connect(audioContext.destination);
            });
    }, [socket, setData]);

    useEffect(() => {
        if (!socket || !roomId || roomId === '') return;
```

Figure A.5: Negotiation module code to create negotiation between farmer and buyer.

The snippet A.5 represents the Negotiation Module, which facilitates the negotiation process between farmers and buyers to agree on a price for agricultural product transactions. This module provides a platform where both parties can engage in discussions and propose offers until reaching a mutually beneficial agreement. By offering transparency and communication tools, the module empowers farmers and buyers to negotiate effectively, ensuring fair pricing and fostering trust in the agricultural marketplace.

Self-Assessment of Project

Table 5.1: Self Assessment of Project

Self Assessment of Project			
	PO PSO	Contribution from the project	Level
1	Engineering Knowledge: Knowledge of mathematics, engineering fundamentals engineering specialization to form of complex engineering problems	Applied the knowledge of blockchain, image processing and software engineering.	4
2	System Analysis: Identity, formulate, research literature, and analyse engineering problems to derive substantiate conclusions by first principles of mathematics, natural and engineering science	1. Literature survey done on agricultural product transaction using blockchain technology. 2. Existing solution were surveyed. 3. The objectives of the project were set. 4. Knowledge of blockchain, image processing and software engineering was found to be useful in implementing the project.	3
3	Design/development of solutions: Design solutions of complex engineering problems, design system components or process that meet the specified process with appropriate consideration for the public health, safety and the cultural and environmental considerations.	The solution was developed using SDLC's iterative model.	5

4	Conduct investigations of complex problems: Use research based knowledge and research methods including design experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	1. Functional requirements and the basic ideology were determined by literature survey. 2. Analyzed the existing framework's working. 3. Solutions that suited the problem statement were developed.	3
5	Modern tool usage: Create, insert and apply appropriate techniques, resources and modern engineering and tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	Ganache, metamask, flask, latex and visual studio code are the tools used for implementation.	5
6	The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	1. This project helps farmer to sell their agricultural product and to analyse the quality of product. 2. This project helps buyer by facilitating transparent transactions, to access accurate information about the products they purchase. 3. This project will provide a secure platform for legitimate intermediary to provide their service such as storage, transportation, packaging.	4
7	Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	1. This project is sustainable, with challenges of market dynamics. 2. This project is upgradable with additional features, such as to enhance the platform to work for more agricultural product transaction and to asses the quality of those product.	4

8	Ethics: Apply ethical principles and commit to professional ethics and norms of the engineering practice.	1. Transaction made by each and every user is recorded. 2. Report is scrutinized and plagiarism check is made with drillbit portal. 3. Reference are quoted.	4
9	Individual and Team Work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.	1. Each student took up the responsibility of executing one module of the project. 2. The report content was contributed by each of the team members. 3. Integration of the modules was done as a team work. 4. Incorporating the suggested changes was done. 5. As a team presentations and demonstration of the project was given.	4
10	Communication: communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1. Phase-wise presentation and demo of progress of project work before the panel. 2. Presentation and demonstration of project before industry experts. 3. Preparation of report spread across the entire semester. 4. Regular interaction with guide and panel members to update the work done throughout the week. 5. Answering queries during presentations and project demonstration.	4

11	Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	1. Maintaining project diary. 2. Incorporation of suggestions given by industry expert. 3. Implementation of suggestion for changes given by the panel members.	3
12	Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in broadcast context of technological change.	1. Working on blockchain technology and image processing. 2. Reading research papers and articles on agricultural product transaction using blockchain technology.	4
13	PSO1: Computer based systems development: Ability to apply the basic knowledge of database systems, computing, operating system, digital circuits, microcontroller, computer organization and architecture in the design of computer-based systems.	1. Develop a blockchain system to track and authenticate every transaction within the agricultural supply chain. 2. Implement advanced image processing to analyze grain quality accurately. 3. Create user-friendly mobile and web applications for stakeholders to access real-time information.	4
14	PSO2: Software development: Ability to specify, design and develop projects, application software and system software by using the knowledge of data structures, analysis and design of algorithm, programming languages, software engineering practices and open-source tools.	1. Adopt an iterative model for software development, allowing continuous refinement and enhancement of agricultural technology solutions. 2. Develop user-friendly applications for farmers, buyers, and intermediaries to interact with agricultural data, transactions.	3

15	PSO3: Computer communications and Internet applications: Ability to design and develop network protocols and internet applications by incorporating the knowledge of computer networks, communication protocol engineering, cryptography and network security, distributed and cloud computing, data mining, big data analytics, ad hoc networks, storage area networks and wireless sensor networks.	1. Create user-friendly internet applications for accessing agricultural data and conducting transactions. 2. Facilitating communication between farmer and buyer for price negotiation.	4

Level	Grade
poor	1
average	2
good	3
vgood	4
excellent	5