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Decentralized Application for Selling Agricultural Production through Block Chain

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Abstract: Farmers in developing countries encounter formidable challenges in obtaining fair prices for their crops. Due to their limited bargaining power, they often find themselves in disadvantageous positions, as wholesalers exploit this vulnerability by purchasing their produce well below its actual market value. Nevertheless, the emergence of blockchain technology has piqued the interest of experts who see it as a potential solution to foster equitable crop pricing for both farmers and purchasers. This study delves into the concept of using block chain-powered bidding mechanisms to create a more balanced environment between these two stakeholder groups. To achieve this, we delve into existing research that highlights the drawbacks of current systems and examine ongoing block chain implementations within agricultural markets. An intriguing aspect of blockchain is its decentralized nature, which holds the promise of enhancing trustworthiness by ensuring transparency. This, in turn, can curb fraudulent activities during transactions, ultimately leading to a fairer pricing system. However, this approach is not without its challenges. Technical limitations pose a hindrance to full-scale implementation, as do financial constraints. Despite these roadblocks, applying block chain in the agri-food industry can revolutionize the status quo by reducing manual interventions, streamlining transactions, and introducing traceability through the block chain. This technological advancement can significantly boost operational efficiency, furnish stakeholders with accurate insights, and champion transparency and accountability within the supply chain. In essence, the overarching objective is to foster dependable economic development opportunities by establishing sustainable models tailored to address the predicaments faced by rural communities worldwide.

Keywords: *Blockchain technology, bidding mechanism, transparency, trustworthiness, agricultural markets, reliable economic development, rural communities*

1. Introduction

The agricultural market has long grappled with volatility in prices and a lack of transparency, posing significant challenges. A primary concern is the exploitation of farmers by wholesalers who purchase their produce at unjustly low rates, resulting in unequal earnings distribution. This issue profoundly impacts farmers' livelihoods and revenue, underscoring the need for solutions. Block chain-based bidding systems have emerged as a potential remedy, leveraging smart contracts and block chain technology to imbue auction processes with transparency, security, and equity. This article delves into the application of block chain-based bidding systems to ensure fairness in agricultural markets and assesses their potential implications for both farmers and wholesalers. Among the diverse applications of block chain technology in the agricultural sector, sealed-bid e-auctions stand out, offering promise for transformative change. However, the conventional sealed-bid approach comes with drawbacks, including transparency, impartiality, and security concerns.

Revolutionizing Sealed-Bid E-Auctions:

In response to these limitations, a novel sealed-bid e-auction technique has emerged to rectify these shortcomings. This innovative approach harnesses block chain technology, smart contracts, zero-knowledge proof protocols, and the Pedersen

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commitment algorithm to ensure privacy protection, transactional fairness, and security. Importantly, this solution eliminates the need for intermediary auctioneers, yielding benefits such as heightened efficiency, cost savings, and enhanced security. Furthermore, this design ensures bidder anonymity and validates winning bids without requiring a third-party auctioneer.

Impact on Stakeholders: Farmers and Wholesalers

The adoption of blockchain-based bidding systems holds transformative potential for farmers and wholesalers alike. Through heightened transparency and security offered by these systems, farmers gain confidence in fair pricing for their crops, while wholesalers can rest assured that they are making justified payments. Moreover, the integration of blockchain-based bidding systems streamlines processes, leading to increased efficiency and reduced operational costs. By bypassing the need for third-party intermediaries, auctions become more efficient, leading to potential profit boosts for both farmers and wholesalers.

Advantages of Blockchain-Based Bidding Systems Over Traditional Methods:

Blockchain technology offers a multitude of advantages that can revolutionize the agricultural supply chain, as articulated by Gopi Krishna Akella et al. Firstly, traceability becomes feasible, allowing participants to track and validate transaction data across the network. This enhances food safety, supply chain integrity, and information on food origins. Transparency, a pivotal feature, differs from centralized systems by maintaining and validating transaction data across distributed locations, ensuring changes are broadcasted to all participants.

Block chain's provenance feature strengthens the network's understanding of transaction sources, work validation, and ownership proof. These bridges the gap in food provenance found in current ICT-based farming applications. Disintermediation, enabled by blockchain, reduces intermediaries through a peer-to-peer network, resolving information asymmetry, and enhancing latency time. The technology's cryptographic foundation bolsters security by chaining blocks sequentially, making data tampering arduous. User private keys further secure transactions against hackers.

Decentralization, the hallmark of blockchain, eliminates the need for centralized servers or third parties, storing transaction data across multiple nodes. This autonomy fosters financial transaction empowerment while fostering savings by obviating the reliance on third-party providers. In conclusion, blockchain technology offers a transformative potential, enhancing traceability, transparency, provenance, disintermediation, security, and decentralization within the agricultural supply chain. This comprehensive advancement can pave the way for a more intelligent, secure, and efficient agricultural industry.

2. Literature Review

Blockchain technology has garnered significant attention across various industries, including agriculture, due to its potential to enhance transparency, security, and efficiency in supply chain management. Within the agricultural context, blockchain has emerged as a promising solution to address the challenges faced by farmers when selling their crops in a fair and transparent manner. One notable proposal involves the implementation of a blockchain-based bidding system to facilitate crop sales [6].

In a study by Yi Hui-Chen et al. (2018), a smart contract-based sealed bidding system was introduced to prevent bid price leakage by the leading bidder. This innovative system harnessed blockchain technology to ensure secure communication, authentication, and data transfer between bidders and auctioneers. However, it was noted that the complexity of smart contracts could potentially lead to issues where bidders and auctioneers inadvertently called the wrong contract function.

Yi-Wei Chang et al. (2019) proposed a blockchain-based e-marketplace designed to enable direct transactions between buyers and sellers without the need for intermediaries. This approach promised advantages such as reduced commissions and improved transaction efficiency. Nevertheless, the study acknowledged the challenge posed by the rapid growth of blockchain tree structures, which may demand substantial computing power for transaction validation [7].

Hang Xiong et al. (2020) conducted a comprehensive examination of blockchain technology applications in various facets of agriculture, including food supply chains, agricultural insurance, smart farming, and agricultural product transactions. The study highlighted blockchain's potential to alleviate the

recording and transactional challenges faced by smallholder farmers while emphasizing the need for further investigation into the motivations driving participants to supply accurate and truthful information to the blockchain ledger [1].

In a 2016 proposal by Feng Tian, an agri-food supply chain traceability system based on RFID and blockchain was put forth to enhance food safety and quality within Chinese agri-food markets [4]. This system aimed to bolster traceability and transparency in the agri-food supply chain but noted potential challenges, such as the high cost associated with RFID tags and the establishment of such a traceability system.

Guilain Leduc et al. (2021) observed that many existing agricultural frameworks built on blockchain primarily focus on food monitoring and traceability. They proposed an e-auction system based on blockchain to ensure the privacy, non-repudiation, and irrevocability of electronic seals. However, they also recognized the need for a centralized middleman in the bidding system to facilitate communication between bidders and auctioneers, acknowledging the potential impact on transaction costs [8].

A case study conducted in China highlighted the critical issue of food safety and its direct or indirect impact on public health and quality of life. While traceability systems have been employed as effective means of managing and controlling product quality and safety, their accuracy and applicability to the Chinese market have been questioned. To address these concerns, Daniel Tse et al. (reference number not provided) explored the potential of blockchain technology in securing the food supply chain and compared it to traditional supply chain systems.

In summary, the existing literature underscores the potential of a blockchain-based bidding system for farmers to sell their crops in enhancing transparency, security, and efficiency within the agri-food supply chain. However, challenges such as smart contract complexity, RFID tag costs, and the necessity of a centralized intermediary in certain scenarios must be carefully considered. Further research is warranted to gain insights into the motivations driving transacting parties to provide accurate and truthful information to the blockchain ledger. Therefore, a comprehensive understanding of existing frameworks and technologies is essential before the implementation of a blockchain-based bidding system in agriculture.

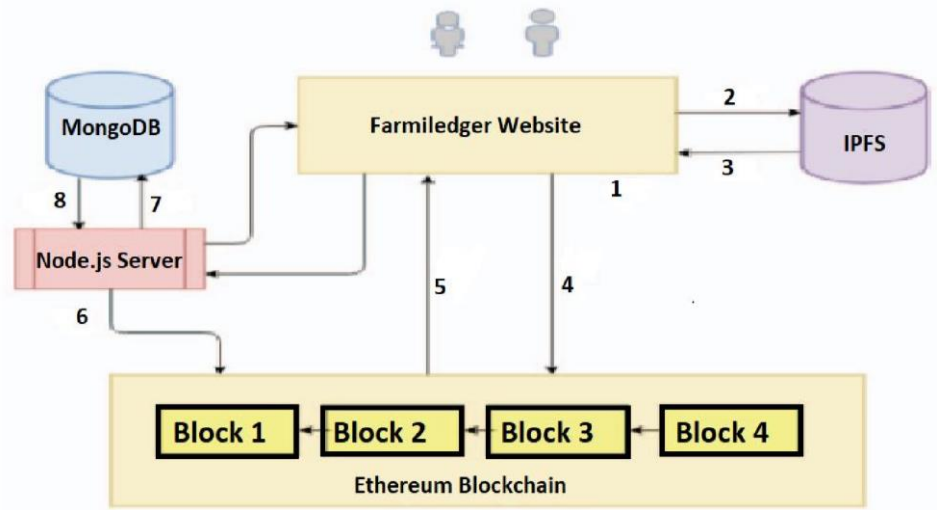

Fig 1: Flowchart Illustrating the Process or Workflow

3. Methodology

To establish a robust and equitable digital marketplace for agricultural produce, the following methodology is employed. It begins with farmers registering on the Decentralized Application (DApp) and providing crucial information about their farms and cultivated products. This foundational step sets the stage for a transparent and efficient process. Subsequently, farmers list their produce for sale, offering real-time updates for potential buyers. Buyers, particularly wholesalers, engage in the platform by bidding on these listings, initiating a dynamic interaction between both parties. With the highest bidder automatically matched with the seller through smart contracts, the transaction process becomes

streamlined and impartial. Post-matching, buyers and sellers negotiate and finalize the transaction details, encompassing payment methods and delivery logistics. These negotiations culminate in the secure recording of the transaction on the block chain, ensuring transparency and reducing fraud risks. Additionally, the DApp enables real-time tracking, empowering farmers to monitor their sales and payments while granting buyers access to their purchase history, fostering greater transparency and accountability throughout the process. Figure 1 visually represents a flowchart that provides a graphical overview of a specific process or workflow, making it easier to understand and follow.

The process we outline in this study is divided into several distinct sections, each with its own set of procedures and functionalities designed to create a seamless and fair agricultural marketplace. The following subsections provide a concise description of each step in this process, starting with Farmer Registration, where farmers establish their profiles within the system, and proceeding through Product Listing, Buyer Bidding, Smart Contract Matching, Negotiation and Finalization, Smart Contract Recording, and finally, DApp Tracking. Together, these stages form a robust framework that leverages blockchain technology to enhance transparency and efficiency in crop pricing and transactions within the agricultural sector.

Farmer Registration:
Farmers initiate their participation in the system by registering with the Decentralized Application (DApp). During registration, they create a comprehensive profile that includes essential information about their farm and the specific types of crops they cultivate. This profile serves as a valuable resource for potential buyers, enabling them to gain insights into the farmers and their agricultural products.
Product Listing:
Subsequently, farmers utilize the DApp to list their agricultural produce for sale. These listings contain crucial details such as the type of produce, available quantity, and the desired selling price. What sets this platform apart is its real-time updating feature, which empowers farmers to keep their listings current. Buyers benefit from having access to the most up-to-date information about the products available for purchase.

Buyer Bidding:
Buyers, typically wholesalers, browse the array of listings featured on the DApp and express their interest by placing bids on the products they wish to procure. This platform not only facilitates the bidding process but also encourages interaction between buyers and farmers. Buyers can pose questions, engage in negotiations, and arrive at mutually agreeable prices.
Smart Contract Matching:
The heart of the system lies in its smart contract infrastructure. Through automation, the highest bidder is intelligently matched with the seller. This mechanism ensures fairness and efficiency in completing the transaction, all without the need for third-party intervention.
Negotiation and Finalization:
Following the smart contract matching, the buyer and seller enter into discussions to finalize the transaction. They deliberate on various aspects, including payment methods and delivery logistics. Options include making payment prior to product collection or upon the completion of the transaction, and they can also decide on the mode of delivery, such as in-person pick-up or shipping.

Smart Contract Recording:
Once both parties agree on the terms of the sale, the smart contract system securely records the entire transaction on the blockchain. This unalterable ledger ensures complete transparency and immutability, significantly reducing the risks associated with fraud and disputes.
DApp Tracking:
The DApp further enhances the user experience by providing real-time tracking capabilities. Farmers can closely monitor the progress of their sales and payments, gaining insight into their financial transactions. Simultaneously, buyers can access a comprehensive history of their purchases through the platform. This dual tracking feature contributes to greater transparency and accountability, empowering both parties to easily oversee their transactions. Figure 2 illustrates how data storage functions within the block chain system. It showcases how information is securely recorded and stored across multiple interconnected blocks or nodes.
This comprehensive methodology combines innovative technology with user-friendly features, ultimately fostering a fair and efficient marketplace for agricultural produce.

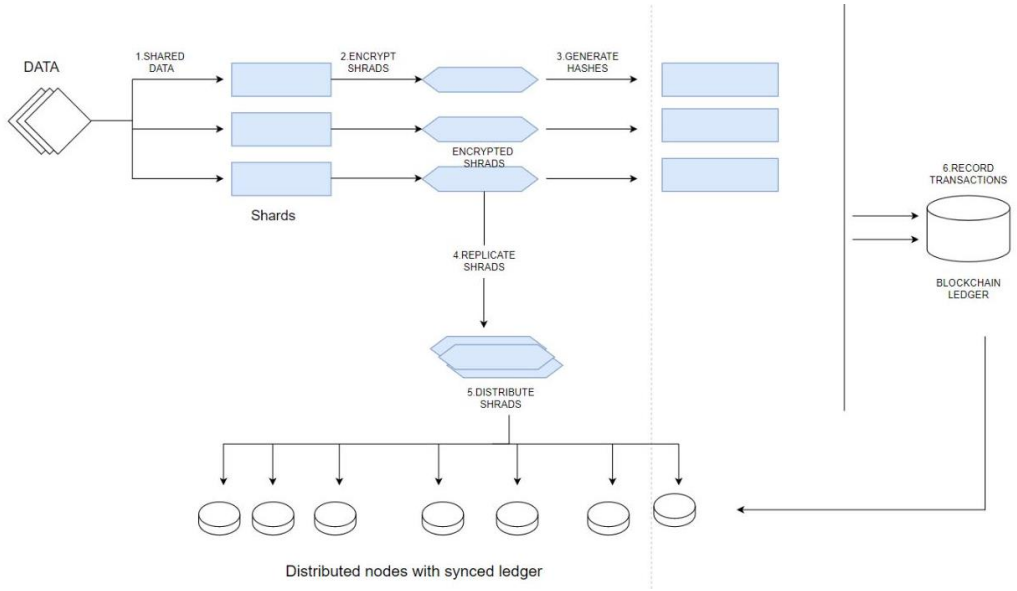

Fig 2: Storage mechanism on Blockchain

4. Results and Discussion

The agricultural sector stands to gain significant advantages from the implementation of an application that facilitates online auctions for farmers' products. Firstly, this technology enhances transparency within the market. Farmers can engage with wholesale buyers on a transparent digital platform, allowing them to make well-informed decisions about pricing by viewing all bids made by potential buyers. This increased transparency also reduces the likelihood of intermediaries taking advantage of farmers.

Furthermore, the app expands farmers' market reach. By introducing e-auctions, it enables farmers to connect with wholesale buyers who may not have been accessible through traditional channels. This broader market access not only ensures that farmers can secure better prices for their produce but also provides them with a wider audience for their goods. Additionally, the app plays a crucial role in minimizing agricultural waste. It achieves this by directly connecting farmers with wholesale buyers, streamlining the sales process and reducing the time during which products are vulnerable to deterioration. This, in turn, contributes to a reduction in agricultural waste.

The app also provides farmers with access to real-time market insights, including trends and pricing information specific to their crops. This valuable data empowers farmers to optimize their agricultural practices and make informed decisions regarding the timing and pricing of their product sales. Moreover, the efficiency gains offered by e-auctions are noteworthy. The app automates the bidding process, making it faster and more efficient than traditional auction methods that often require physical presence. This efficiency benefits both farmers and wholesale buyers.

Lastly, the convenience factor cannot be overstated. Farmers and wholesale buyers can seamlessly conduct auctions through the app from the comfort of their homes or workplaces. This digital approach reduces the time and costs associated with physical auctions, making the process more convenient and accessible overall. In conclusion, the introduction of this application holds promise for transforming the agricultural landscape by leveraging technology to improve transparency, market access, efficiency, and data-driven decision-making for farmers and wholesale buyers alike. Figure 3 displays a user interface screenshot of the FarmiLedger application, offering a visual representation of its design and functionality.

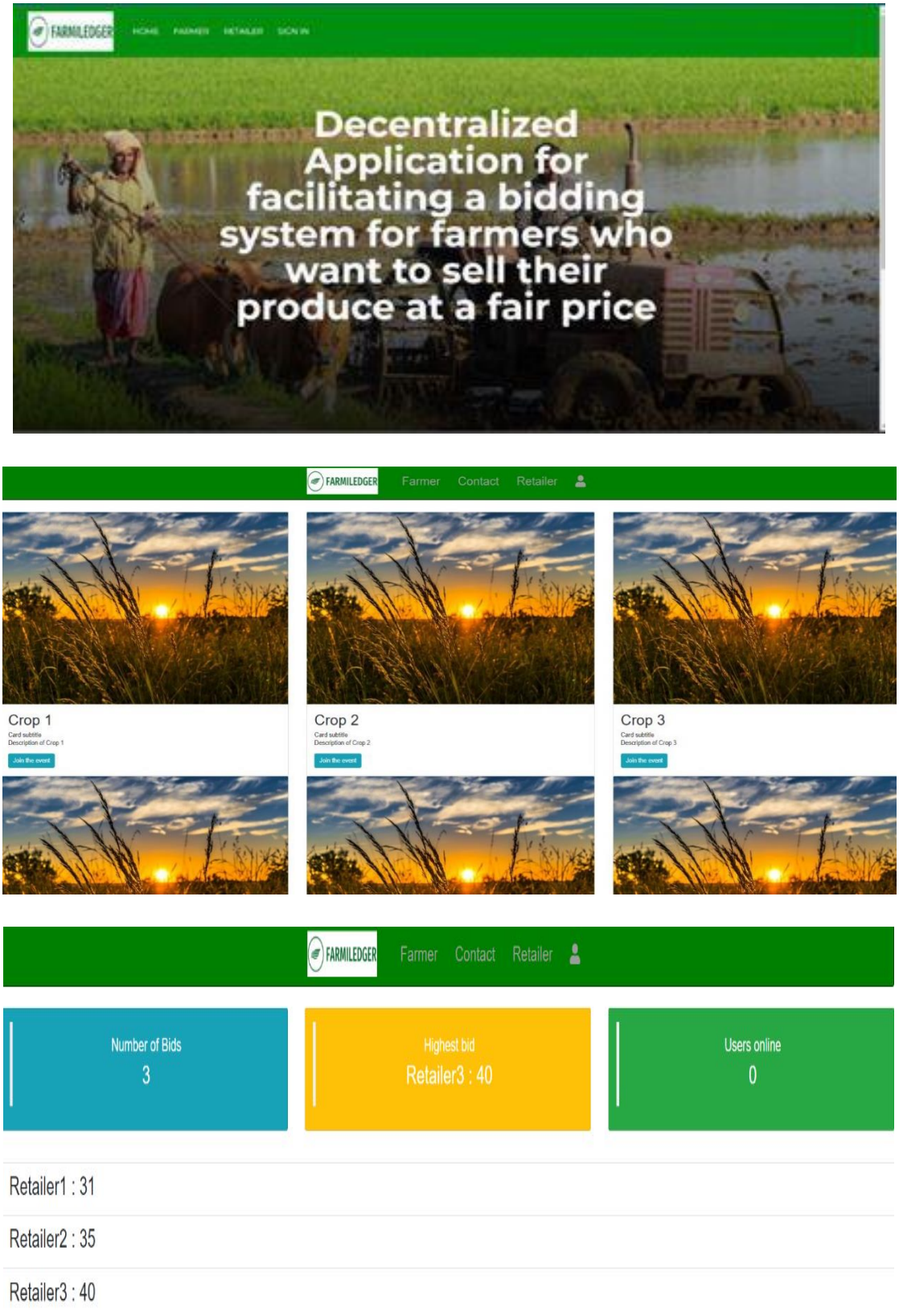

Fig 3 : Visual Representation of the FarmiLedger Application's User Interface (UI)

4. Conclusion and Future Scope

In summary, the introduction of an application facilitating e-auctions for farmers' goods among wholesale bidders holds immense potential for enhancing multiple facets of the agriculture sector. It has been demonstrated that this technology can significantly bolster transparency, market reach, operational efficiency, and overall convenience

within the industry. Furthermore, it plays a pivotal role in minimizing agricultural waste and provides farmers with invaluable real-time market data, empowering them to make informed decisions.

FarmiLedger, as an exemplary solution, stands as a game-changing innovation poised to revolutionize the agricultural landscape. Rooted in blockchain technology and a decentralized application framework, FarmiLedger not only simplifies the buying and selling of agricultural products but also guarantees transparency, security, and efficiency. Features like smart contract matching, negotiation and finalization, and real-time tracking offer a seamless experience for both farmers and retailers, promising transformative benefits.

The future scope of FarmiLedger and analogous systems is brimming with exciting possibilities in the realm of agricultural data management and blockchain-based solutions. One avenue of development involves the integration of artificial intelligence (AI) and data analytics into FarmiLedger systems. This advanced integration can furnish farmers with sophisticated insights and predictive analytics. Machine learning algorithms can analyze the wealth of agricultural data amassed through FarmiLedger platforms, providing personalized recommendations for crop management, yield optimization, and resource allocation.

However, the realization of these future prospects hinges on several critical factors. These include ongoing technological advancements, the establishment of supportive regulatory frameworks, the degree of market adoption, and the evolving requirements of farmers and the broader agricultural industry. By actively exploring these avenues, FarmiLedger stands as a catalyst for advancing and transforming agriculture, thereby championing sustainability, efficiency, and innovation within the sector.

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