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Blockchain: To Improvise Economic Efficiency and Supply Chain Management in Agriculture

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Abstract*: As the population of the world is growing at a rapid pace. By 2050, projections show that there will be 9.2 billion people on the planet that needs to be feed. Farmers need more sustainable and productive ways to be employed to seize a prominent place in the market with compelling profits. One effective way to do that is by using Blockchain to eliminate the middleman and scaling the product effectively. A Blockchain is a distributed and immutable ledger that holds a permanent record of transactional data. It operates as a decentralised database managed by the peers in the network eliminating the middleman. Blockchain helps the farmers to secure more profits, achieving them at least 30% more than what they are earning by currently followed conventional techniques. Especially in the Indian market, the price gap is high between producer and retailer due to the intervention of a middleman. Blockchain not only increases the profits but also ensures the authenticity of the product in real time, providing the customers and peers more information about the product as it is easier to trace the details of the product back and forth through the chain. This also enhances and regulates the price variations providing farmers with the best price they can expect for their product. This will gradually increase the involvement of more people and drives more investors towards the agriculture industry, funding more agriculture-based businesses increasing food production that can be able to feed the massive population sooner.

***Keywords* : Blockchain, Economic Efficiency in Agriculture, Smart Agriculture, Supply chain Management.**

I. INTRODUCTION

The world is at stake with a rapid increase in population, as every human need to be fed, there will not be enough food to feed the large populations by following conventional techniques. There is a huge wasting of food every day with a parallel increase in large masses who are suffering from famine and global hunger which affects almost 11percent of the population [2]. The growth of e-Commerce, and in-app purchases, coupled with the increasing mobility of people around the world, have filled up with the growth of transaction ledgers.

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Blockchain offers traceability by helping food companies managing food inquiries or investigations fast and effortlessly.

Beginning from farm originated details to transportation details, batch numbers, food processing and factory, warehouse data, expiration details and other details digitally linked to the products within the blockchain, consumers or firm members can traverse everything by backtracing the supply chain. As the food supply chain is based on the blockchain, it can help different stakeholders to access information related to the food's quality at every stage which increases security and transparency.

A. Decentralization:

Decentralization refers to any kind of technology that there will be no governing authority by any organizations. This is arguably the main highlight of crypto-technology and blockchain technology. Since decentralization doesn't involve in any sorts of central node and completely relied on a network of independent, individual users, the concept of Blockchain is this collection of users itself.

And also decentralization brings transparency [9], it is easier to get the proper required data which is authentic.

- It gives an open platform for both suppliers and buyers to negotiate for reasonable prices of their products. Suppliers can make direct mobile payments to buyers. This eliminates intermediaries and brokers.
- Retailers, farmers, and manufacturers can claim premiums of some products by using this technology. It is a distributed ledger since it shares information across many computer networks which are operated by an independent individual without relying on the central dictating authority.
- This technology has the prospective to tackle the issues and problems in the agricultural and food industry remarkably. Farmers in the modern world have always fascinated the technology that delivers real value. Present-day farming will be improved if blockchain technology is effective and intrigued.
- From digital identity management to a micropayment system, blockchain based resolutions has been dabbed to small non-existent and traditional other nations infrastructure and push the new era into huge growth.

B. Security:

The biggest concern for every person who involves in transactions is its security. Here security generally denotes both safety and privacy.

If the blockchain is not secure enough, no one will risk such insecure platforms for investing.

However, there are multiple ways to ensure that people have secure access to their invested funds. One such method is using crypto wallets, which have their digital address and can be part of online service platforms that connect you to a specific blockchain and allow you to buy and sell. Typically, SHA-256 (secure hash algorithm 256) [4] is the most secure and widely used hashing technique to encrypt the data, this is employed in the blockchain. SHA-256 [4] is unbreakable as each hashed block will have 2 power 256 possibilities to guess and crack the hash code. It is typically a 256-bit block cypher algorithm which encrypts the intermediate hash value using the message block as key [4].

C. Scalability:

Scalability defines the blockchain's ability to increase its capacity at the same time maintaining smooth operations. It means eliminate slow processing times, system bloating, lags etc. Blockchain is generally getting larger and larger due to its immense popularity and demand. This system must be able to handle multiple transactions per second that are requested by users should be executed and computed parallelly at compelling speeds to withstand the competition of fast-growing technological innovations. We are talking of nearly millions of transactions per second. This consumes a lot of power and hardware resources to process the information faster to compute multiple transactions parallelly.

II. EXISTING SYSTEM

The typical product sales system comprises of producer, wholesaler(middle-man) and retailer. The product from the producer will be first sold to the wholesaler then wholesaler cuts a deal with the retailer, finally the product will be sold in the market at the retailer's price leaving producer to make lesser profits and consumer to pay the hefty price for the product. The intermediaries between the farmer and the final consumer of most agricul-tural commodities are more in numbers, which leads to the large price gap between the producer selling price and the retailer's price. Therefore, the to-tal profit margin going to the traders in between is a huge part of the market price. Typically, the intermediaries do not play any commercial role. This affects the farmer a lot leaving him with lesser profits in spite of efforts invested and expenses incurred. The loss for the farmer in the transition is too high, thus this should be overcome by using emerging technologies like blockchain.

Common tricky practices are witnessed in rural markets. The whole process of transaction is against the benefit of the farmer. In the market, the farmer has to approach a broker/wholesaler to be able to dispose of his pro-duce to the supplier or retailer. The proposed system will provide the farmer with power and authority over the system which leads to more profits to the farmer and lowering the prices of commodities.

III. PROPOSED SYSTEM

The vivid focus of the proposed system is to reduce the intermediaries and increase the scalability of the product using blockchain in agriculture. The system is focused on improvising the economic standard of farmers in agriculture, agricultural economy and food security with more transparency in the system. This can be achieved by employing blockchain in agriculture by eradicating the middleman and provide us with data which is more authentic. Scalability if the data can also be useful to predict the patterns in the agricultural industry and use that data to improvise and yield more from the mistakes made in the system over time.

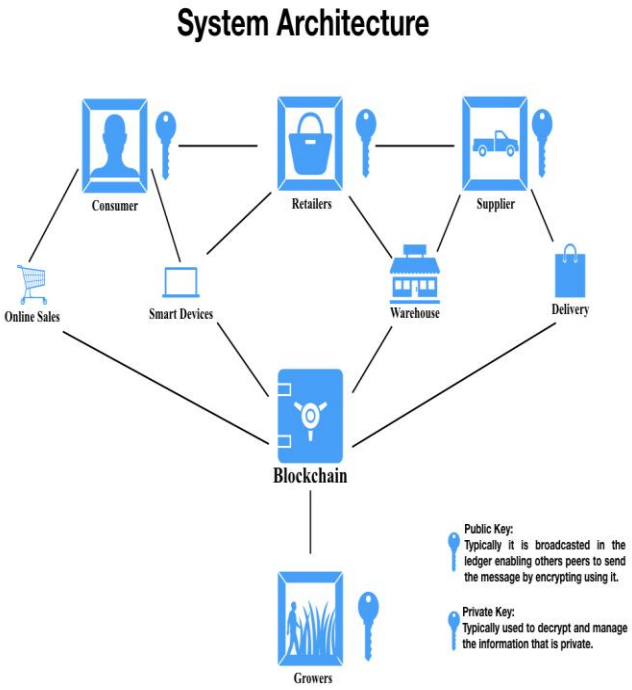


Figure 1: System Architecture of proposed system

Note:
The system may not be maintained by the farmers.
The blockchain service provider may host it and store data online.

A. Flowchart:

This Flowchart explains the working of blockchain in the agricultural industry. It comprises of the peers in the blockchain, the peers are consumers, retailers, suppliers and growers in the network. The grower or the farmer will have whole authority over the system, he can assign all the privileges for the peers and sell the products at his price. Each transaction is authenticated by most of the peers in the system, this increases the transparency in the system which will reduce the prices of the products to the end consumer at the same time helping farmer gets the best price he can.

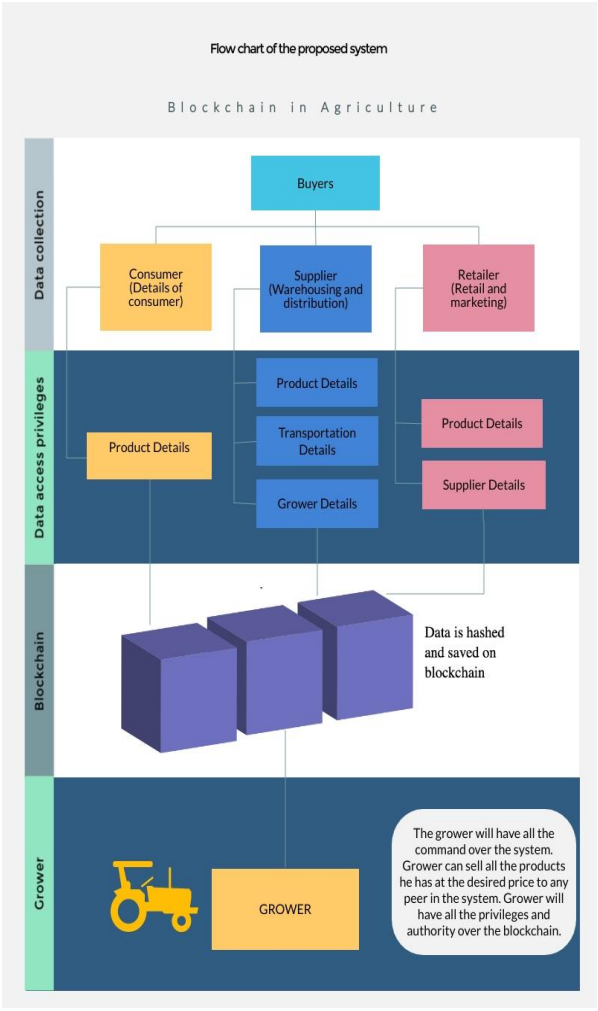


Figure 2: Flowchart of the proposed system

a. Data Collection and warehousing:

All the transactional will be stored inside the blockchain which can be used for future improvements and to deduce sales patterns from the data stored over time. This data can also be useful to find the product authenticity with real-time consistent back-tracing offered by blockchain. With the increase in scalability through the chain solves the problem of food security as one can precisely scale the product to the initial stages like where it produced and packaged, this helps to find the damaged product and solve the problems easily.

b. Consumer:

The data of the final consumer will be stored here and the consumer can buy the desired product through the chain similar to buying a product through an online retailer.

c. Supplier:

The Supplier will deliver the product to far-off places, takes care of the transportation and shipping the product. The supplier may be a third party supplier who sells to the foreign markets.

d. Retailer:

The Retailer sells the product to the customers directly through the stores in an area or the producer may himself can act as a retailer. The data of the producer and consumer can be helpful to maximize the profits for the producer based on the price pattern derived from the blockchain.

e. Data Access Privileges:

This is controlled by the authority or owner of the blockchain-i.e., farmer, who sells the products through the chain. Typically consumer will have the privilege to buy and update his details over the chain. The supplier will have more privileges to negotiate the prices based on the supply-demand. Product details supplier details will be accessed by the retailers to choose the best deal among the supplier to supply the product based on the selling prices of the producer to the supplier, this will help to tackle the predatory pricing due to transparency of data.

f. Blockchain:

The data of all the transactions are converted into blocks of data where each data is then hashed and stored as a chain of blocks. Immutability of the data is the standout feature of the blockchain as each transaction made with the reference of the previous node in the chain, thus no transaction will proceed without the completion of the current transaction. Thus it is almost impossible to break the chain and manipulate the data that is hashed with SHA-256 and stored as a chain of blocks.

Figure 3: Showing the chain of transactions.

g. Public Key:

The public key [4]is used to verify authenticity when a message is signed with the private key and sent to the receiver. The public key can also be used to encrypt the data which can be decrypted by using receivers private key.

h. Private Key:

The private key [4]is used to sign the digital document and send to the receiver where he'll verify the authenticity of the message. It can also be used to decrypt the data if the data is encrypted by the public key.

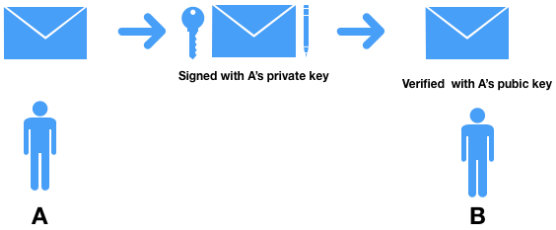


Figure 4: Digital Signature Standard.

Note:

The type, amount and verification may be different for each blockchain.

IV. RESULT AND DISCUSSION

To estimate the increase in profits by eliminating the middleman using blockchain, prices of rice sold [6]of producer, wholesaler and the retailer dataset is created from the multiple datasets acquired from Food and Agriculture Organization of United Nations [7]. The datasets obtained from FOA are analyzed and prices are normalized according to the requirements of the system and easy understanding. The profits are estimated based on the expenses for the maintenance of blockchain. To keep it simple we took the average of producer selling price and the wholesale price to get the estimated price after eliminating the expenses for maintaining the blockchain.

The profits may differ based on the attributes considered. The producer may even sell at higher prices which will increase the profits drastically. The estimated price is vague and considered only to show how blockchain can seize compelling profits to the producer.

Year	Yearly Producer Price	Yearly Wholesale Price	Yearly Retail Price
2000	132.6	220.79	256.04
2001	124.6	198.29	227.29
2002	124.1	187.61	221.46
2003	134.2	199.52	223.75
2004	187.5	217.00	237.71
2005	203.6	234.01	253.96
2006	211.2	242.65	255.21
2007	236.4	271.93	302.71
2008	272.7	319.59	342.29

Table 1:

This table shows the different selling prices by producers, wholesalers and retailer in India. (2000-08)

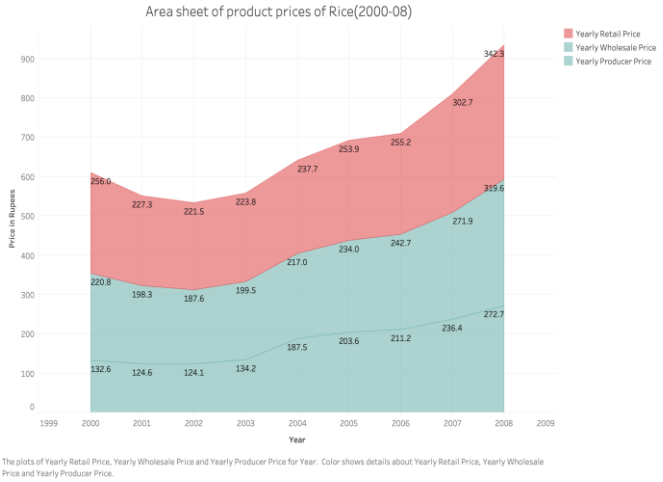
The data is obtained from FOA [7]

Estimated Price = Average (Yearly Producer Price, Yearly Wholesale Price)

Year	Estimate Price (The farmer can sell directly to the retailer using Blockchain.)(Average of producer price and selling price)	Estimated Profit gained by Framer (Using Blockchain) (Estimated Price-Producer price)	Profit Increase in Percentage. (Estimated %)
2000	176.695	44.095	33
2001	161.445	36.845	29
2002	155.855	31.755	25
2003	166.86	32.66	24
2004	202.25	14.75	7
2005	218.805	15.205	7
2006	226.925	15.725	7
2007	254.165	17.765	7
2008	296.145	23.445	8

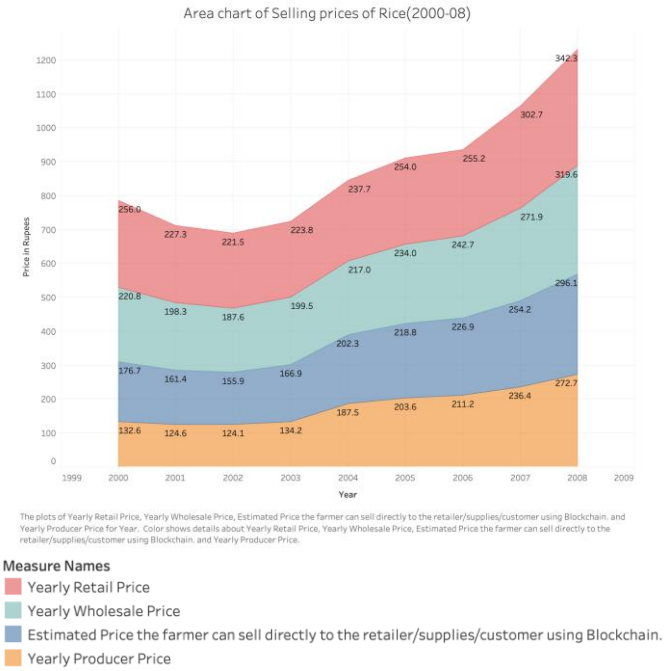
Table 2:

Table showing the estimated prices and profit obtained in rupees and percentage.



Area chart:1

This chart shows increase in selling price of producer, if he sells at the price of middle man which leads to compelling profits and stable market.

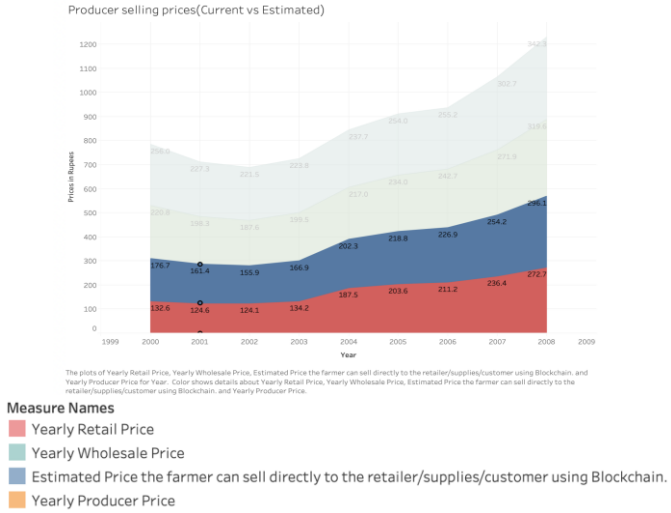


Area chart:2 Depicts variation of prices of rice through the conventional system and also shows the estimated selling price of rice by producer is increased by using block chain. Chart shows all the price variations of rice (2000-08).

Finally, we can conclude that blockchain will be a profitable and efficient way to be employed in agricultural practices.

This would be the best solution to overcome the supply chain management barriers [5] and also increases the financial stability of the industry with data transparency the prices will be more stable.

The final chart will emphasize only on the price difference of profits obtained by the producer using conventional methods versus the estimated selling price by producer using blockchain.



Area Chart :3 Price variations of producer selling prices following conventional practices versus estimated producer selling prices using blockchain.

V. FUTURE ENHANCEMENTS

There is a compelling future for the application of blockchain in agriculture. In further research, we intend to improvise the scaling techniques in blockchain and integrate blockchain with IoT and machine learning for better understanding of agriculture industry, which helps to find more efficient ways that make the world a sustainable place to live. It has the power to change the entire agriculture industry by interpreting the data stored that helps to make wise decisions by choosing the right crops at the right time.

VI. CONCLUSION

The blockchain is still an upcoming technology, but it has the potential to revolutionize many industries. Food security and efficient agricultural practices should be improvised to tackle the rapid growth of population [1]and climate change. Without efficient agricultural practices and supply chain management, the world may face serious food scarcity. The technological advancements like blockchain can be a very useful and effective way to be employed as it can increase the economic efficiency and revolutionize the supply chain management. The global agriculture trade estimated over two trillion dollars and has over a billion people involved globally. It can be helpful to find profitable ways by interpreting patterns from the data stored in the chain. Blockchain has the potential to drive more investors and young minds to innovate for the agricultural advancements with its compelling benefits. Thus we can conclude that blockchain has wider benefits with its minimal limitations in scalability. Overall, this technology will revolutionize the way different actors in different industries to communicate, manage the supply chain, access information on a secure, shared, and transparent platform.

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